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THE POTATO

IN FIELD AND GARDEN.

BY

W. J. MALDEN.

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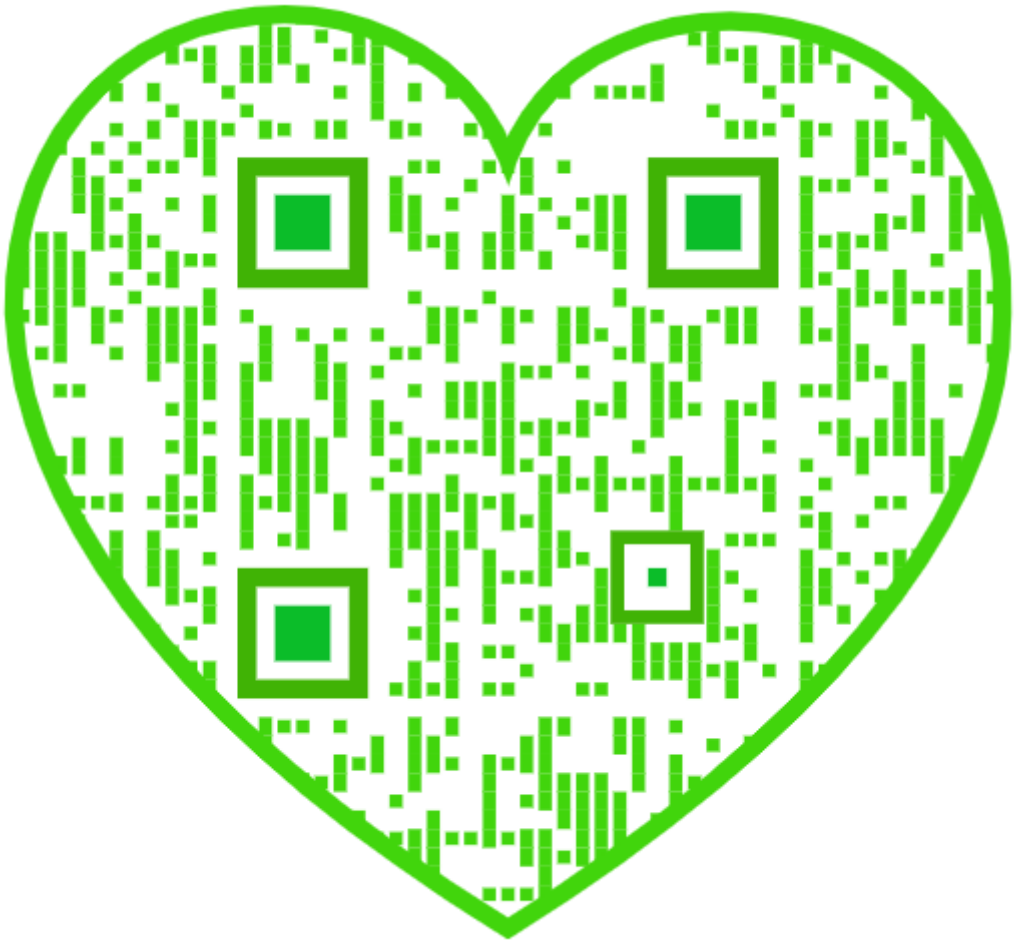

UNIV. OF CALIFORNIA

THE POTATO

IN FIELD AND GARDEN.

BY

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THIS BOOK IS DEDICATED TO

JAMES TALBOT POWER, ESQ., D.L.,

OF LEOPARDSTOWN PARK, CO. DUBLIN,

A sincere and energetic friend in the cause of Irish Farming, in which the cultivation of the Potato forms so prominent a feature,

In grateful testimony of the kind and ready assistance he—as Vice-Chairman of the Committee of Agriculture of the Royal Dublin Society—accorded to

THE AUTHOR

During the two years he was associated with Irish Agriculture.

526674

PREFACE.

THE introduction of better varieties of potatoes, the adoption of more economical methods of dealing with the crop, the discovery of means for keeping in check diseases of the plants, have made potato growing an art which can only be successfully carried out where the farmer or gardener is abreast of the times with regard to information on all these points, as home and foreign competition are very strong. The want of more perfect knowledge in individual cases causes a very large portion of the crop to be grown unprofitably. Those who thoroughly understand the subject, and cater for the best markets, find it a profitable business, although they may not be otherwise better situated than their less successful neighbours.

The endeavour in this book has been to present to readers the experience I have gained in living the greater part of my life in a district which has long been celebrated for potato culture, and more particularly to explain the methods of cultivation and general treatment of the crop we have found most profitable in growing nearly 200 acres yearly. As I have been associated with potato growing in several other districts in England, as well as in Ireland, I have had an opportunity of seeing what is best suited to all classes of soils and climates, and, therefore, am able to

write confidently on the subject. At the same time I am pleased to acknowledge the great assistance I have received from Prof. Marshall Ward, Dr. Munro, Mr. E. C. Beaven, and others, who kindly placed at my disposal a considerable amount of scientific information they have obtained during their researches in connection with diseases, and other interesting features connected with the potato plant. I am also indebted to them for several excellent illustrations they have permitted me to use.

Although a subject of general interest, the literature dealing with potato culture is very limited, and most of it is hardly in accordance with modern practices. It is only fair, however, to give credit to the large seed firms for the useful information they have circulated on the subject, as well as for the substantial aid they have given growers by the introduction of new varieties of potatoes which possess so many valuable features. My thanks are due to them for the illustrations of types of potatoes which they have kindly supplied; also to those implement makers who have placed their illustrations at my disposal.

W. J. MALDEN.

Cardington, near Bedford.

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THE POTATO.

SECTION I.

THE CROP.

Introduction.

THE importance of the potato crop is shown in the fact that more than half a million acres in Great Britain are devoted to it in field culture annually. This is in accordance with the returns of the Board of Agriculture, and relates only to that portion of the crop grown in open field cultivation, which does not include the enormous quantity grown in private gardens. It is impossible to give even an approximate estimate of the quantity raised in gardens and small patches not included in the returns; but that it is very large can be understood when it is remembered that it forms the principal crop in all vegetable gardens and allotments. The extension of the allotment system has had a greater effect on the acreage of potatoes grown than is shown in statistics or is generally realised. In 1894 the field crop of Great Britain was 504,454 acres, 20,907 less than in the previous year, when, owing to superabundant production, prices were so low that many who grew them found the crop no more remunerative than was wheat, for which it had been

substituted. The acreage of potatoes now grown, assisted as it is by surplus supplies from other countries, yields more than are required by the population, except in seasons when, from disease, frost, or drought, the yield is seriously affected ; consequently, the profitableness of the crop is not so marked as it was some few years ago, and those who obtain high prices are those who grow potatoes of superior quality. The development of potato cultivation should be in the direction of improvement of quality rather than in increased acreage. In Ireland, where the country is farmed to a great extent by small holders who do not possess much capital, and who are not prepared to exert themselves very much on their land, potatoes form a large portion of the arable-land cropping, as a greater supply of food is obtained from potatoes than can be raised by any other crop on the same outlay of capital and energy. The acreage amounts yearly to 717,000 acres, and during the past ten or fifteen years this has been almost entirely devoted to the Champion, though the folly of adhering to a worn-out variety is shown very plainly by the fact that it has become so subject to disease that, in any but the most favourable seasons, a potato famine occurs, and a cry of distress is set up by the people at the loss of their staple food.

On the Continent large quantities are grown, the surplus beyond those required for home consumption being sent to England, and as water freight is so cheap they reach the English markets more cheaply than many grown in England. It is often urged that English

growers should prevent this importation by growing more, but this would not meet the case, as those which are imported come if they realise as much as their feeding value where grown. As many as possible are sold at home, but those not required are exported, as it is the only way to turn them into hard cash. It is assumed that the profit is obtained on those sold at home.

Large quantities are grown in Jersey, where they can be brought to maturity at a much earlier date than in England. These realise the highest prices, as they are put on the market when new potatoes are a luxury restricted to the rich. When the English grower can put his on the market the highest prices are no longer attainable. Similarly the Scilly Isles, Canary Isles, Malta, and Egypt have exported considerable quantities during the past few years, which arrive before the English potatoes are fit to dig, some in fact before the Jersey potatoes are dug. This has been a source of considerable loss to English growers, and no corresponding gain to the consumer, beyond the fact that he can obtain a luxury a few weeks earlier in the season, for the potatoes could be grown in England equally well; in fact, the quantity grown for culinary purposes is in excess of requirements.

Origin of Cultivated Species.

The potato, *Solanum tuberosum*, is a plant belonging to the order *Solanaceæ*, in which order are several plants employed for the sustenance and comfort of man. The

tomato, *Lycopersicum esculentum*, is valued for its succulent fruits, and the tobacco, *Nicotiana tabacum*, for the narcotic properties of its leaves. Neither the leaves nor the fruits of the potatoes are consumed, its value lying in the tubers, large distensions of underground stems formed by the accumulation of starchy matter, very valuable as animal food, in the manufacture of starch, and distillation of spirits.

The common potato, *Solanum tuberosum*, is quite distinct from the sweet potato, but is closely allied to several solanaceous plants, though only a portion of these produce tubers. Five tuber-bearing species are found in Chili, four in Peru, Bolivia, Ecuador, and Colombia; one and a variety in Brazil, eight in Mexico, and two in the South-Western United States. The variety *tuberosum* is found in the two first-mentioned divisions. Mr. J. G. Baker, in his paper in the "Journal of the Linnæan Society," stated that of these there are only six genuine species in the broad sense, viz., 1, *Solanum tuberosum;* 2, *S. maglia;* 3, *S. commersoni;* 4, *S. cardiophyllum;* 5. *S. jamesii;* 6, *S. oxycarpum.* Of these, in addition to *S. tuberosum*, *S. maglia* and *S. commersoni* yield an abundant supply of edible potatoes; but although the two latter produce edible potatoes they are not such as find favour in popular taste. Any attempts to substitute these for the *S. tuberosum* have not been successful, nor can it be said that hybridising with *S. tuberosum* has been a success, notwithstanding repeated efforts in that direction. Most of the hybridising has been done with the

view of gaining for the potato greater vigour than the *S. tuberosum* possesses in withstanding attacks of fungous diseases. Not only has hybridisation by means of the flowers been attempted, but grafting with the view of gaining fresh characteristics in the plants from seed produced in this manner has been tried, though not with sufficient success to lead to the hope that the potato grower can look forward to any material assistance from it in the future.

Introduction to Europe.

The research which has been carried on in connection with plants closely allied to the potato has, however, been productive of much useful information. The physical constitution of the potato is undoubtedly impaired by the special treatment to which it has been for so many years subjected. The Spaniards appear to have been the first to bring the plant from its habitat in South America in the early part of the sixteenth century, and before the end of the century it had been introduced to most of the countries of Western Europe. Its introduction to England is associated with the name of Sir Walter Raleigh, who brought over specimens from Virginia late in the century. The Virginia stock originally came from South America, as the plant is not indigenous to North America. It is claimed that it was known in Ireland some years before Sir Walter Raleigh introduced it; like so many introductions to that country, it is supposed to have been washed ashore from a shipwreck. One way or another

several stocks have found their way to Europe, and it is doubtless due to the different stocks that so much variation in shape, colour, habit of growth, and other characteristics is met with among the varieties in cultivation to-day.

Effect of Cultivation on the Plant.

Had but one stock been available it is probable that the plant would have suffered more from in-breeding than it has, although there is little doubt that too close breeding is the cause of much of the physical weakness apparent in modern varieties. Throughout the centuries the potato has been in Europe it has been subjected to systems of cultivation which have tended to develop the tuber at the expense of the seed. Comparatively few of the solanaceous plants produce tubers; the life of almost all is perpetuated from year to year by seeds. There appears to be considerable doubt as to why the varieties which bear tubers should have developed this peculiar method of reproducing life from year to year; but it appears to be a special provision of nature to meet the exigencies of the exceedingly hot and dry climates in which they are found growing wild. Under ordinary conditions the seed of a plant is produced in a climate which is favourable for its germination and growth; consequently, there is no need to provide special means for its propagation. In climates like that of Chili the growth of potatoes from seed, through want of moisture sufficiently early in the season, might be impossible. Nature appears to have

wonderful resources when they are needed to maintain the life of species, and the tuber is probably a means which the potato plant instinctively, as it were, called to its aid to help it hold its place in the vegetable world.

The Formation of Tubers.

The most striking feature in connection with the tuber is, that although formed underground it is not a portion of the root, but is a portion of an underground stem. The seed of the potato is contained in fruits borne on the stem or branches above-ground. Even those solanaceous plants which develop tubers retain the faculty of producing seed, unless the conditions under which they are grown are persistently antagonistic to seed production. This happens when all efforts are diverted towards the development of tubers, in consequence of treatment strongly opposed to the growth of the plant under natural conditions. The tuber, although frequently called seed, and to which reference is made when speaking of "seed potatoes," is not a seed in the true sense; nor is it a root, or a portion of root, as in the case of the carrot. A tuber is an enlarged portion of an underground stem, several of which are usually formed on one plant. It is not until the plant has made considerable growth that these stems attain appreciable size. As the plant approaches to maturity they grow rapidly, and may be easily distinguished from the true roots, as they are usually thicker, whiter, and free from rootlets. If the extreme tip of these branches is examined it is seen that there

are two small leaves, forming as it were a bud. These leaves are very close together, placed in a very similar manner to two hands laid palms together lengthwise. Instead of these leaves parting and spreading out in opposite directions they are brought into closer contact, as starchy matter, developed in the leaves on the above-ground branches, is gradually carried down the stems and deposited between them. The greater part of the starchy matter not required to support the plant is conveyed to the underground stems, and accumulates between these small leaves. In a short time the leaves become distended, but they are equal to the occasion, for as the starchy granules become attached to them they lose their leaf-like properties and develop into skin. The tubers increase in size, but the skin develops rapidly enough to form a covering to them, and in course of time the tuber, as it is commonly called, comes to maturity. In the tuber a number of buds, commonly known as eyes, are formed, and these lie dormant until various changes within, and favourable conditions without, start them into growth. The contents of the tuber then become food for their support until the roots develop, and the young plant can take nourishment from the soil. The tuber is therefore the distension of a leaf-bud at the end of an underground stem, the distension being caused by an accumulation of starchy matter manufactured in the leaves, and brought there to be stored as a reservoir of food to support the life of the buds when they start to grow, and until they have developed into plants

able to take sustenance from the soil. When the soil becomes unusually consolidated, so that the tubers cannot form below-ground, they form on the stem at the base of each branch. When this occurs they become green, as chlorophyl is formed in sunlight. The most striking feature of these above-ground tubers is that in course of time, while the stem is still green, the buds or eyes sprout, and form green leaves similar to those on other parts of the plant.

Reproduction from Seed.

The reproduction of potatoes from year to year is not dependent on the tubers, though for the sake of economy it is convenient to employ them for that purpose. Although the power of producing seed has not been altogether destroyed, still the plants feel the effect of the treatment to which they have been for many centuries subjected. The natural function of the plant is to reproduce seed, the cultivation determines that it shall produce tubers. The treatment which is necessary to the development of tubers is antagonistic to the plant's performing its natural functions. Where nature is interfered with in one direction for any length of time constitutional weakness invariably follows. It is the same in the animal and vegetable kingdom. An animal living under natural conditions is much more reproductive than one which is kept in confinement and so treated that its energies are devoted towards the laying on of fat. Not only is such an animal more productive, but it retains a vigorous constitution, able to

throw off diseases to which its more pampered brother would succumb. Many generations of special treatment have rendered the potato comparatively weak in constitution, as is evidenced by its aptitude to succumb to various kinds of disease which affect it very slightly when growing in a state of nature.

Necessity for the Production of New Varieties.

Until within comparatively recent years the life of a particular variety was much longer than is found in the average of instances now. Before the outbreak of *the* potato disease, in 1845, varieties were kept in cultivation longer than was profitable, but, as there was no special disease to resist, the fact of their having become enfeebled was not readily noticed. When the disease appeared most of the varieties were without vigour to resist it, and the devastation was correspondingly intense. Greater attention has since been bestowed on the cultivation of the potato, and all growers of experience realise that the profitable life of a variety is short, and that it is necessary to obtain new varieties.

Means of Obtaining New Varieties.

New varieties, so far as they are suitable for market purposes, can only be obtained from strains of the original stocks; fortunately, the original stocks develop many different characteristics and features which are very diversified in their nature. The diversity is so strong that when by cross-fertilisation they are brought together so as to form a new variety, many of the

weaknesses which are the outcome of close breeding are not presented, while the vigour which is expected from the alliance of two distinct strains is frequently obtained, though this is not invariably the case. New varieties can only be obtained by cross-fertilisation, that is by fertilising the anther of the blossom of one with the pollen from the blossom of another plant. Endeavours have been made to obtain new varieties by cutting out the eye of a tuber of one variety and inserting it in a corresponding hole in a tuber of another variety, but this has not the desired effect. It is analogous to budding a rose on to briar, the result of which is that above the place where the bud was inserted there is a rosebush possessing the characteristics of the bush from which the bud was taken, but below it is still the briar. The two have not been changed, each retains its own particular features, and there is no intermingling. A bud from one tuber inserted in another will grow and take up nourishment from the one in which it is placed, but though it assimilates the food it does not partake of its physical characteristics. It is true that slight variation has been noticed occasionally, but potatoes are so liable to produce sports or hidden features that those few variations which have been noticed are not regarded as indicative of new and stable varieties. Until within the past few years new varieties were obtained from the seeds taken haphazard from the fruits or apples of any potato, but systematic crossing was not practised. It was found that one apple would often produce seeds which de-

veloped several distinct varieties. This was due to the fact that the plants were grown in the open, where the pollen from any number of varieties could reach the blossom and help in the fertilisation. Occasionally a new variety possessing high qualities was obtained and found a place in cultivation, but all was a matter of chance, and no one could definitely say what its breeding was. Of recent years the crossing has been carried out on scientific and systematic lines, with much more satisfactory results. Even now, however, the crossing of two varieties of high repute may not necessarily produce offspring worth development. In fact, a very small proportion of those raised are found worth bringing into cultivation. They may not show characteristics differing from the parent stocks; they may not have developed the extra vigour which is desirable, or they may be distinctly less valuable than either of the varieties from which they sprang. The mere fact of crossing two varieties, however good they may be individually, does not ensure an improvement. The success obtained hitherto does not warrant the statement that the hybridiser can obtain any feature he may desire, though it must be admitted that a few have commanded an extraordinary share of success. The good results which have attended the efforts of a few of the most notable hybridisers prove that it is not a matter of chance. During the last few years Mr. Findlay, of Markinch, has been very successful, and no one would say that his many successes were entirely due to chance. Previously Mr. Clarke, the raiser

of the Magnum Bonum, was also highly successful; many others might be mentioned who have done good work on systematic lines. To be successful in crossing it is necessary that the experimenter should be thoroughly acquainted with the features of the potatoes he is treating with. The mere knowledge that they have proved profitable in cultivation is not sufficient, although it is a good groundwork to start upon. The breeding of these varieties must be known, so that they may be mated to neutralise weaknesses and develop the better features contained in them. Varieties the result of crossings often possess latent characteristics which are brought into prominence when they are mated with other suitable varieties. To be successful in variety-making it is important that the experimenter should possess an innate acquaintance with all features of the potatoes he is going to deal with, otherwise much of his labour will be futile.

Points to Develop in the Production of New Varieties.

The points which it is most important to endeavour to develop are vigour, power of resisting disease, and quality. Without vigour the new variety will soon become unprofitable, as the yield will be small, and the plant will quickly succumb to the diseases which are lying wait for it. Robustness is indicative of disease-resisting properties, but not entirely so, and it is necessary to use as much as possible varieties which have proved themselves disease-

resisting. If it is wanting in quality it will be useless, as bulk without quality finds no place amongst growers for culinary purposes. It is better that a new variety should tend rather to excessive robustness than to the other direction, as all varieties become weakened in course of time; if there is not a little superabundant vigour when it is developed it soon becomes too weak in its constitution to be profitable, and has to be withdrawn from cultivation. The time of maturity, and the property of being fit to cook at certain periods of the year, are also important features. The idiosyncrasies of consumers must also be considered, for the demand for particular types is very variable.

Development of New Varieties.

Having decided upon the varieties which shall be mated together, it is a very important matter to select the tubers carefully. The best examples should be selected and planted, and again selected for two or three years until the highest type is attained. Having done this they should be planted in a position which will allow them to be kept apart from others during the flowering season. Some varieties, notably those which produce tubers early in the year, are very shy bearers of blossom, and considerable trouble is occasioned in obtaining seed from them. The blossoming is much assisted if the tubers are prevented from being formed, as the energies of the plant are then directed towards developing flowers. Some varieties which had never been known to produce blossom have been

made to blossom by this means, and new varieties have been obtained by crossing from them. When entertaining the idea of crossing varieties it is obviously necessary to regulate the time of planting so that the plants of varieties which, under ordinary circumstances, do not produce flowers at the same time, may be made to do so simultaneously, otherwise a year may be lost.

It is found that flowers of one plant do not fertilise other flowers on the same plant, while the pollen from another plant does so very readily. In fact, the fertilisation is too readily effected, as the experimenter experiences great trouble in keeping alien plants from affecting those with which he is treating. The potato is one of those plants which is fertilised without the aid of insects. The fine pollen dust is readily transported by wind, and so susceptible is the plant that the seeds from one plant are frequently found to produce potatoes of many varying types. When systematic hybridisation is carried out it is necessary that the plants employed should be kept perfectly isolated, or true crossing will in all probability be interfered with. Most hybridisers prefer growing them in houses where they are under easy control; but at any rate, from the time that the buds begin to show signs of opening the plants should be placed under glass shades. When the flowers are developed the shades should be opened just sufficiently to permit the hand to be inserted. The blossoms gathered should be covered before being withdrawn from the shade, and it is best to open the shade on the side opposite to

the direction of the wind, as there is less likelihood of foreign pollen being blown in to the plant. The gathered blossoms should be carefully inserted into the shade containing the other plant, and the pollen should be shaken on to the growing blossom. For greater safety the pollen may be laid on the stigma of the plant, but this is hardly necessary. So that the energies of the plant may be directed towards the fertilisation of the flower and the development of seed, it is wise to leave but few blossoms on the plant, and all immature blossoms should be destroyed. The plants should be kept isolated until there is no doubt that fertilisation has been effected, when they may be allowed to develop the seed under natural conditions. When the "apples" or fruits are ripe they should be gathered and stowed away to dry. Subsequently they should be placed in water until they become plump again; the seeds can then be squeezed out, and after being washed should be allowed to dry, when they may be stored until spring. If left dry until the spring the seed may be rubbed out, and should be sown in a fine tilth, the seed being deposited about half an inch below the surface. The plant will grow in the ordinary manner, and when it comes to maturity it will in all probability be found that there are a number of small tubers about the size of a bean, or larger. These will have to be planted in the following spring, when they may attain the size of a hen's egg, and the produce of each year should be planted in each subsequent spring, until at the end of four years the tubers

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will have developed to the full size. By this time an experienced judge of potatoes will be able to form an idea of the probable value of the stock; an estimate of the vigour of the variety, its yielding powers, shape, depth of eyes, colour, habit of growth, cooking capabilities, and other characteristics can be arrived at, so that its probable value as a new introduction can be ascertained. The stock may not be altogether of one type, as potatoes are liable to "sport," that is to produce, among others, specimens which differ from the majority. These sports should not be discarded without attention, for many good strains and varieties have been obtained in this way.

New Stocks.

If there is nothing particularly valuable and distinctive about the new stock it will probably be best to discard it, and give attention to other selections. If, however, the stock appears likely to possess exceptional value, its further development should be proceeded with. This is a simple matter. Every living eye is a plant in embryo, so the potato should be cut in such a manner that as many plants as possible shall be obtained. Sufficient substance of the tuber should be left about the eye to ensure its growing. All that is necessary is that enough food shall be left to start the young plant into life and maintain it until the rootlets take possession of the soil sufficiently to support it on the food found there. It is obvious that the food in the soil shall be plentiful and in such condition that it may be easily seized by the roots. To ensure this it must be well

manured, and reduced to a fine friable state. The ordinary practices of potato-culture will then suffice to give good results. The development of stocks has been furthered by dividing the stems. This method is best suited to those varieties which carry strong haulms or stalks. Each shoot thrown out by the tuber is in reality a plant, and if a set containing several eyes is planted, a number of plants are set growing. These, if undivided, grow as one plant; but if carefully divided, so as to carry with each stem a small portion of root, will, if transplanted, become separate plants. To reap full advantage from the transplanting the plants should be put into a well-prepared seed-bed. The yield from these divided plants is far in excess of that from the plants when grown collectively as one plant.

SECTION II.

SOILS.

During the past few years, since wheat has become an unprofitable crop to grow, the extent of land available for potato culture has been so largely increased that, unless the cooking properties of the tubers are very good, potatoes are as unprofitable as the crop they have supplanted. The potato markets are almost always glutted with inferior ware, which barely pays the farmer for the expense he has incurred in its production. Except in seasons when, through severe attacks of disease, drought, frost, or other exceptional reasons, the yield throughout this country, as well as on the Continent, is greatly reduced, long and paying prices for inferior ware are not obtained. The uncertainty of the crop affords a chance for it to occasionally prove more remunerative than a grain crop, as if the attacks which have proved disastrous to others have not affected a special farm or district, those unaffected naturally benefit by the increased prices which a curtailment of the supply induces. In fact, the speculative features of the crop are a great inducement to those who are suffering from prolonged unremunerative prices for other produce to engage in its growth in the hope that fortune will specially favour them. Satisfactory prices

obtained by skilled growers on favourable soils are quoted, and those with little experience hope to obtain similar ones, even though circumstances are not suitable. These and other reasons have induced many farmers to take up potato growing under conditions which are not favourable to profitable growth. While other foods are cheaper it is only natural that consumers should be more particular as to the quality of the potatoes ; consequently, there is sufficient difference in the price of potatoes of good quality and those which are inferior, to make all the difference between a satisfactory return or an absolute loss to the grower. It is certain that success in potato growing can only be ensured in these times by growing the choicest varieties on suitable soils. Other details have a great influence in ensuring success, but these two are absolutely essential. Occasionally, from special causes, remunerative crops are obtained under conditions which are ordinarily unremunerative, but they are so exceptional as to be more likely to mislead than otherwise.

Soils adapted to Potato Growing.

Undoubtedly the best potatoes are grown on the Old Red Sandstone. Taking one season with another they are far superior to those raised on other soils. Potatoes raised in the Dunbar district invariably obtain the full market quotations. The Greensand and the New Red Sandstone rank very high in the estimation of growers. Alluvial soils generally produce good quality, though this is not always the case. Most soils of a light nature,

in which there is an intermingling with gravel, are productive of potatoes of good quality; but those with an excess of gravel sometimes suffer in droughty seasons. The peaty soils of the Fen, commonly spoken of as "Black Land," produce heavy crops, but except in hot dry seasons the quality is very poor. Thin chalky soils, the opposite of the Black Land, are not profitable for potato culture, as they are too readily affected by drought, and on many there is not sufficient soil to "earth up" the rows. Light but deep soils containing a plentiful supply of lime are usually favourable to the growth of the crop. Heavy soils, such as the clays, are emphatically not suitable for the crop, as the quality of the potatoes is poor except in very dry seasons, the land is difficult to get into condition for planting, in wet seasons the cleaning operations cannot be properly effected, and the digging is almost an impossibility in wet autumns. Beyond this, the crop is particularly liable to disease. Whatever the soil is, unless the subsoil be porous good results cannot be obtained, nor will they be achieved if the land is not sufficiently drained.

Drainage.

Good drainage is the first essential in the preparation of the land. One of the best fields we farm was valueless for potato culture until it was drained, since which it has never failed. The soil in this field is a very light friable loam, with a sandy subsoil, and so far as the ordinary signs of want of drainage went they were almost entirely absent. One feature, however,

was noticeable, the field was the constant haunt of plovers, which found a plentiful supply of insects at all times. The potatoes grown previously to the draining were always infested by insects, in fact in some seasons when turned out of a sack they made the well-known rustling, suggestive of dry leaves in motion, which has earned for these hollowed-out tubers the name of 'Whistlers.' The Julus worms which were the chief cause of injury, as well as other insects, rapidly disappeared, and for many years there has not been any serious damage done by them, and those intelligent indicators of the want of drainage, the plovers, have forsaken the field. The presence of an abnormal quantity of insects—frequently the cause of most extensive injury to the potato crop—is almost always due to the unhealthy condition of the soil, and as unhealthiness of the soil is most commonly brought about by excessive moisture, not always plainly indicated, it is highly important that the land should be examined and closely watched, in order that stagnant water may be detected and got rid of.

Favourable Conditions of Soil.

The potato flourishes best on deep, warm, friable soils with open and well-drained subsoils; so, whatever the nature of the soil on which a crop is to be planted, it is necessary to produce these features so far as mechanical means permit. Successful cultivation is associated with the best tillage. It is admitted on all hands that autumn cultivation conduces to the

most thorough disintegration of land; consequently, whenever opportunity admits, land on which potatoes are to be planted should, at any rate, be ploughed early in autumn. Even on land which can, in most seasons, be relied upon to come down to a good tilth by the time for planting, it is a wise precaution to get the work in as forward condition as possible, as in wet springs the few fine drying days may not be sufficient to work the whole of the land required into a suitable seed-bed. Also, in exceedingly dry springs, land which is ploughed for the first time frequently becomes hard and harsh, unfavourable for the growth of potatoes. When in the furrow through winter, the soil is brought under the influence of climatic variations, especially frost, which have a beneficial effect, as the particles are shattered apart, allowing free circulation of air. Land brought to a fine consistency by frost does not anneal again readily, as the air produces changes in its physical and, probably, chemical properties which permit it to dry quickly after rain without forming a paste. The necessary treatment of the soil is very dependent on its nature, the condition in which it is found at the time the preparation commences, and the rotation of cropping in which it takes a place.

Systems of Planting.

Before dealing with the preparation of the land, according to the rotation of cropping pursued, it is well to mention the methods of planting most commonly adopted. These are the Ridge or Drill, the Flat, and

the Lazybed (usually called the Ridge in Ireland). It is probable that the Drill is the most successful on the whole, though under some circumstances the Flat is most suitable. The preparation of the land for these two systems may be practically similar until just previously to planting, except that it is usual on the Drill system to apply the manure immediately before the seed is put in. The land is laid alternately in ridge and furrow by means of a double-breasted plough. The dung is then laid along the furrows, the potatoes placed upon it, and the ridges are split by the same plough, so that new ridges are formed where the furrows had been, thus covering in the potatoes.

The Flat System.

When potatoes are planted on the Flat the dung is most commonly applied at any time previously between autumn and the planting season, in which way it becomes incorporated with the soil. A fine tilth is prepared as a seed-bed, and the rows in which the potatoes are to be planted are indicated by a cord, or shallow marks are made by a drill or other implement steered straight, and along these lines holes are made by a spade or dibble, into which the seed potatoes are placed, and subsequently covered with earth.

The Lazybed System.

The Lazybed is worked entirely by spade labour, though the earlier operations may sometimes be effected with a plough. This system is valuable on

newly reclaimed bog, where the soil still retains a large quantity of water. Although very frequently adopted on other soils in many parts of Ireland it is not so successful as either of the other two systems described. Where followed under these circumstances it is the outcome of ancient practice without regard to the reasons which prompted its adoption in the first instance. The Lazybed is a narrow ridge of land usually about four to six feet in width, very similar to an ordinary asparagus bed, formed by a trench dug between each ridge, the earth from which is laid on to the ridge. The trench varies from one foot in depth and one in width to two feet in depth and two in width. The trench is not completed at once, but after the land is dug and laid up the potatoes are planted and sufficient earth is taken from the trench to cover the seed. When the crop is growing additional earth is taken out to mould up the stems sufficiently high to cover in the new tubers where they form. The trench thus formed is useful as a channel to carry away superabundant water, and affords an opportunity for the drainage of the surface which otherwise would not exist. By altering the position of the beds the whole of the land becomes moved to a considerable depth in course of time. From various causes, however, the system is one which should not be taken in preference to the two other methods mentioned.

The Potato in Relation to Rotations.

During recent years, owing to the changes which have been necessarily brought about on account of the unremunerative state of corn-growing, much less attention is paid to orthodox rotations. In some districts the course of cropping had not deviated for a long period, but it has been found in many cases that rotations which were suitable when corn-growing was the remunerative part of farming are no longer profitable ; consequently the potato, a crop more extensively grown than in the past, frequently finds a place in rotations which it did not previously take.

The Four-course Rotation.

Where grown in the most simple of all rotations, the four-course, it takes the place of a portion of the fallow or root crop, but the four-course has disappeared altogether from some large districts where it was the only rotation followed. The four-course has more often been extended into a five-course, and the potato crop follows the root crop. When the root crop is fed on the land the soil is usually found to be in good condition manurially, and the working it received when undergoing preparation for the root crop has a beneficial influence on the succeeding crop. When this system is followed it is well to get the roots fed off as early as possible, so as to permit the land being turned over in time to benefit by the frost. If this is not done, and the roots are not eaten at a time when the land is wet, the working of the land

will be attended with great difficulties in bringing it to a suitable tilth at the time the potatoes should be planted, especially if the spring months should be either excessively wet or unusually dry. If the crop is fed on the land there is not much need of additional manuring, particularly if the root crop was manured with farmyard manure. If the land is in good condition manurially the application of a dressing of superphosphate of lime and kainit will be all that is necessary. If manure is applied it is well that it should be put on before the first ploughing if the crop is to be planted on the Flat, but if it is to be put in on the Ridge it is usual to leave it until the time of planting. Artificial manures should be sown on the furrow of the first ploughing, and they will then be well mixed with the soil during the subsequent workings. An exception to this must be made in the case of highly concentrated nitrogenous manures, such as nitrate of soda and sulphate of ammonia, which, owing to their solubility, are rapid in their action, and are best applied after the plants are well above ground. Many who practise the Ridge system prefer to sow the artificials in the furrow at the time the dung is applied.

Preparation of Land under the Four-course System.

The potato is a deep-rooting plant, and as a large quantity of earth is required to cover in the tubers when they form, the soil should be worked to a depth

of at least eight inches. One of the reasons why spade cultivation is found to succeed so well in potato growing is the deep and thorough working of the land. When the potato is grown on the strict four-course rotation it takes its place after a corn crop, and it is natural to infer that the soil is low in condition. It is not improbable that, being at the point farthest from the cleaning or fallow crop, the land is not absolutely clean. If the couch or twitch is in very small patches, which can be dug at slight expense, it may be sufficient to have these dug out immediately after harvest, and as no further cleaning is required it will not be necessary to do more than plough the land and leave it in the furrow through winter. If, however, it is in a foul condition it should be ploughed and subjected to a thorough autumn fallowing. This will lighten the work in spring. Having cleaned the land as much as circumstances permit it is well to put on the dung if it is available. After this it should be ploughed into ridges with a double-breasted plough and left in ridges through winter. If the land is left flat after being worked into a fine state there is great likelihood of its becoming consolidated during the winter rains, when the work of reducing it to a fine and friable seed-bed will be greatly increased. When laid up in ridges, especially if dung is ploughed in with it, the soil is almost certain to work easily in the spring, and the spring work will be of a light nature. The ridges may be levelled by means of curved-tine drag harrows,

and the further cleaning be effected during the operations required to get the land in condition for planting. However, it is generally found that a ploughing in the spring is most suitable, as the work is more thoroughly done; and if there are thistles in the land the roots are cut off and they give less trouble afterwards.

Other Rotations.

Similar methods should be adopted in any of the rotations where the potato is taken after a corn crop. Where potatoes are taken after a crop of "seeds," grass or clover grown in rotation, the treatment varies according to circumstances. If the "seeds" have been down for a lengthened period—two or more years—the produce in the last year is usually not very heavy; and as the land has not been subjected to cleaning for a lengthy period it is most often found that couch has taken possession of the ground to some extent. As there will probably be little growth after the first crop in the season is taken off there will be little waste if the ground is broken up then. This affords an opportunity for giving the land a "bastard" or short fallowing. A late summer fallow of this description possesses most of the advantages of a "dead" fallow without the usual disadvantages. The scorching sun of July and autumn destroys the crop, and if the clods are kept large the couch is killed also. If circumstances permit the couch may be collected and burned, while the roots of the "seeds" will be left in the land to manure it. In preparing the land to face

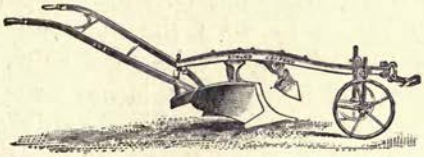
the winter so as to ensure it working well in the spring the condition of the land must be observed. If the land lies in a very rough condition it may be left alone; if, however, it has been reduced to a fine state it should be ploughed or ridged so as to keep it from setting too hard during winter. In spring ordinary methods will be sufficient to bring it into a suitable condition for planting. The manuring should be governed by the same rules as those which apply to the manuring of land after a corn crop.

Autumn Cleaning of Leys.

If the ploughing of the land is deferred until the autumn or approach of winter, when cleaning operations cannot be carried out, the ploughing should be done in such a way as will conduce to the decay of the root and such part of the plant as remains. It is very important that the skim coulter shall pare off a large portion of the surface, so that the growing part of the plants may be buried. A less expeditious, but more effective, method is to plough the furrow in two sections, arranging the work so that the surface may be turned to the bottom of the furrow, and the lower portion of the furrow-slice be turned on to that. When this is done an advantage is sometimes gained, as the subsequent operations may be restricted to the stirring of the top furrow only. In ploughing the root of a "seed" crop it is always necessary to have in view the operations it will probably be advisable to execute in working the land to a seed-bed, as the root may give trouble by

its unsightliness or its persistent endeavours to grow.

Where large quantities of potatoes are grown, and a large portion of the land is planted with potatoes, it often happens that it is not convenient to plough the whole of the land in autumn, but an endeavour should be made to get it done as early as possible in winter. The ploughing should be done, if possible, in dry weather, and a deep furrow, rough or crested, should be turned in preference to one which lies flat. No

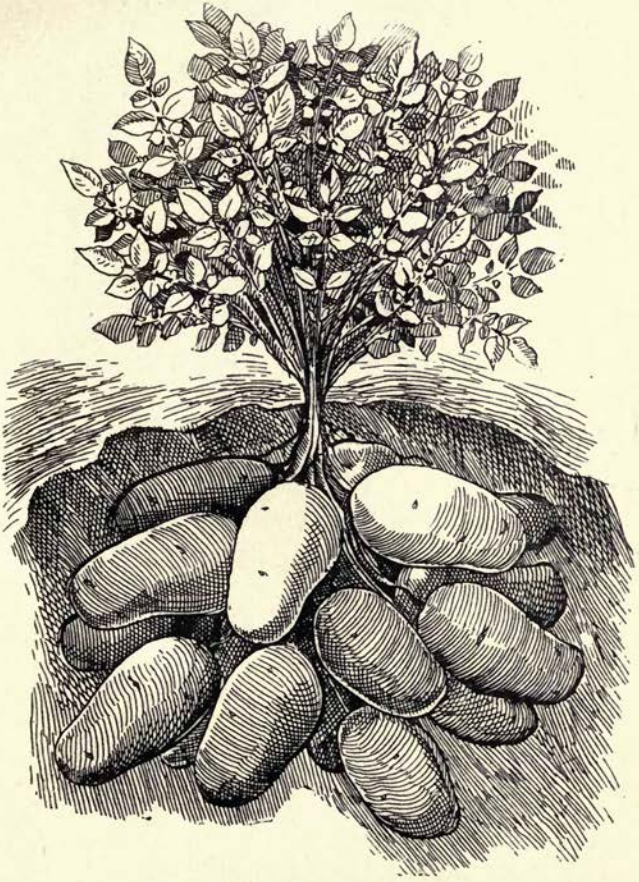


HOWARD'S CHILL-BREAST PLOUGH. FIG. 1.

implement has proved of greater gain to potato growers than the modern chill-breast digging plough. In the place of a solid core, compressed while being turned by the ordinary plough, the furrow is lifted over and falls lightly. The need of frost to make the land friable after the chilled plough is not nearly so great in the first ploughing, and the subsequent ploughings are equally benefited. The draught is much lighter, and the horse-labour throughout the whole of th operations is greatly lightened.

Spade Husbandry.

Where spade labour is employed the land should be dug as early as circumstances permit. The soil should be laid up roughly to benefit by the frosts. Where specially good results are aimed at it is a common practice to trench the soil—that is, to dig the ground two spits deep. If there is a fear that the subsoil contains injurious matter, whether from its physical properties or from the presence of a large quantity of seeds of weeds which lie dormant until brought to the surface, the bottom spit should be kept from coming to the top. When trenching it is necessary to keep an opening or trench between the dug and the undug ground, so that the two spits may be worked conveniently. If the bottom spit is not to come to the surface it should be turned with a spade or fork, as seems most suitable at the time. It is well to break this spit, as it will not be further subjected to cultivation, and a solid spit soon sets back into the condition it was in previously to being dug, thus destroying the benefits aimed at. If dung is applied at the time of the first digging, it may be conveniently buried between the two spits. If the subsoil is not charged with injurious matter it may be brought to the surface, and the top spit be buried in its place. The two spits will work together during future operations, and the soil will henceforth be deepened. If soil is clung, so that it does not leave the spade freely, a fork-spade should be used. This is a four-tined fork, to which a thin bar of steel is welded, so as to give a spade edge



FIDLER'S COLOSSAL.

LATE WHITE KIDNEY.

Introduced by Mr. Fidler.

to it. Land which digs badly otherwise can often be worked readily with this tool.

Spring Work on the Land.

Under most conditions the land has been previously worked by the time spring arrives. The majority of potatoes are planted from the middle of February to the middle of April, according to variety, soil, and climate. However, in some localities planting is commenced in January, especially where budded or sprouted potatoes are employed. Where the latter is practised it is of course necessary to get the seed-bed into condition very early, in fact it is impossible to delay the earlier operations until planting time, and autumn cultivation must have been adopted. As there are comparatively few potatoes planted so early in the season, it is advisable to deal with the treatment of land in its preparation for the general crop, and leave the specially early planted land to be dealt with in the section devoted to the planting of the crop.

It must always be borne in mind that the earliness with which the crop is planted is regulated to a great extent by the climate, although many of the good heavier soils cannot be brought into a properly prepared condition until the dry winds of March have done their work in evaporating excessive moisture. The natural friableness of the soil of course regulates the amount of work required to produce a fitting seed-bed. Light sand soils come to a tilth much more readily than the heavier loams. The operations are

regulated to some extent by the system of planting, whether it is on the Flat or on the Ridge. As the manure on the Ridge system is applied most often at the time of planting, it is obvious that there is no need to arrange for this at an earlier period; but it is very important where the Flat is adopted that the manure, especially the farmyard, and the mineral artificials shall be on in time to become well incorporated with the soil. Therefore, if the dung has not been put on in autumn or winter no time should be lost in getting it on. There is risk in leaving it late, because if the season proves wet the prospect of a good tilth is greatly injured, as the carting tends to consolidate the soil, and frequently prevents a really good seed-bed being obtained. There is no such favourable time for dung carting as when the land is frost-bound.

The great principle to be observed in the spring workings is to work the land *up to a tilth*. By this is meant the whole of the operations should be of a nature which will tend to lighten the soil as deep as it is being worked. A superficial fineness is not sufficient: when the seed-bed is obtained it must be a tilth from top to bottom. Too much treading by horses, particularly when the soil is moist, and the use of rollers to break down the clods, should be obviated by judicious treatment which will pulverise the soil without consolidating it. The digging-plough tends to lighten the soil, whereas the common plough tightens it; harrows or drags with straight tines consolidate it, particularly if the tines are blunt, while

those with curved tines lift the soil and leave it lighter. Avoid whenever possible the necessity of working the land *down to a tilth.* To do this it is often necessary to take advantage of slight frosts; the clods turned while in a frozen condition yield when thawed, and newly-turned clods, which expose a fresh, moist surface, are more effectually caught by frosts which occur on the following night.

Spring Ploughing.

Provided the weather is dry a ploughing in spring may be relied upon to do sufficient good to pay for itself. If the surface is dry it is advisable to harrow the ploughed land before re-ploughing, or before breaking it up with the heavier stirring implements. This operation breaks the surface, and a fine tilth in place of hard clods is turned into the ground. It is a mistake to harrow the soil, if while doing it the horses unduly pound it, as greater trouble will be found in working it during subsequent operations. While it is advisable not to re-plough the land while it is thoroughly wet, it may be well to do so when it is only moist. The treading of moist land previously to the furrow being turned should be avoided by letting the horses walk in the furrow. The horses do not work so freely when single as when abreast, but this is an occasion when the slight loss of power is better lost—it will be more than regained in the future operations.

Working Foul Land in Spring.

Where the land is very foul from the presence of twitch or couch, thistle, willow-weed, or other stout roots which are not killed without exposure, the land requires working so as to bring them to the surface. This is effected by the scuffler and drag with curved tines. The scuffler is the stoutest implement, and is most effectual in breaking up the furrows. These should be followed by the curved-tine drags, and these again by the lighter harrows, which will collect the weeds so that they may be gathered together and be carted away or burned, or if the weather is favourable leave them exposed so that they die for want of moisture. The amount of work will of course be regulated by the quantity of weed to be destroyed. It may be necessary to plough the land once or twice previously to the final preparation for planting, but this can only be decided in the field. One ploughing in the spring is necessary, if only to cut thistles, so that they are kept in check while the young potatoes get possession of the ground. If there are many thistle roots they should be dragged out, as when they are merely turned over in a deep tilth they are only transplanted, and are liable to give much trouble in the crop. The weeds which give the greatest trouble and cause most injury to the crop are thistles, couch, and willow-weed.

The Ridge System.

Where the Ridge system is adopted, as the planting entails two ploughings or ridgings just previously to or during the planting operations, the preparation of the land differs somewhat to that where the Flat is carried out. The land may or may not be ploughed or cleaned very early in the spring, according to circumstances. If ploughed in autumn and the land is friable the stirring by the moulding ploughs may suffice, but if not, additional working is necessary, as the aim must always be to get the land into a light condition. The great point to recognise is that working during wet weather causes extra labour, and that no good opportunity should be missed.

SECTION III.

PLANTING.

The planting of potatoes is effected in many ways. Of recent years machines have been introduced to place the potatoes in the required position, and some of these are of sufficient merit to be considered labour-saving machines. One of the chief points against their more rapid spread has doubtless been the initial cost of purchase, but, where potatoes are planted on a large scale, the expense of planting is lessened by their use. At present, at any rate, the majority of potatoes are planted by hand.

Conditions favourable for different Systems of Planting.

The three systems of planting which embrace in various forms the methods of planting are the Ridge, Flat, and Lazybed. The Ridge is in greatest favour in those districts where the rainfall is above 27 inches annually, while the Flat is most commonly adopted where the rainfall—particularly if the summer rainfall is light—is below 27 inches. The Ridge system has a tendency to divert the water from the ridges, and so keep the land immediately around the plants in a dry condition; whereas, on porous soils situated in dry

districts, it is important to retain moisture about the surface, and to leave as little surface as possible exposed to the effect of sun and wind, and also to make the capillarity of the soil to exert itself, to attract the moisture from the subsoil to the surface in times of drought. The Lazybed is only suitable where, through natural circumstances, such as in newly-reclaimed bog or fen, or in otherwise low-lying positions, surface-drainage is useful to carry off excessive moisture; the raised beds also place the plants artificially higher above the natural water level. Except in water-logged positions, and then only on a small scale, because such situations are not favourable to the production of potatoes of good quality, and only sufficient should be grown for local consumption, the Lazybed system should not be adopted. It cannot be too strongly condemned, more especially as under the conditions in which the potatoes are planted cleaning operations are almost impossible, resulting, as is usually seen in the West of Ireland, in a crop which consists of some potatoes and more weeds. However, the Irish peasant excuses his want of carefulness in respect of cleaning by saying that if he destroyed the weeds the rooks would scratch out the potatoes. Beyond the difficulty of cleaning, effectual spraying to prevent disease is rendered impossible, and it is fast being recognised that spraying is a necessary operation in the cultivation of potatoes. The process of planting is very simple: the ground is laid up into beds, the potatoes are placed on this, and earth from the sides of the beds is dug up, forming a trench, and covered over the sets.

Planting on the Flat.

On the Flat system it is necessary for the bed to be prepared and brought to a fine tilthy condition, the operations being controlled as much as possible to prevent consolidation. When either dibbling or spading-in is adopted, lines or marks to indicate the position of the rows must then be made, and along these the potatoes are planted. Where the plots are small a long cord or gardener's line is sufficient to guide the planter; this is stretched across the field, and is moved as occasion arises for a fresh row to be started. Where large fields are planted the rows should be marked out by means of a drill, or a specially made implement capable of accurate steering. The skeleton frame of a Bedfordshire drill affords the best means for making these marks, and it is useful for any other similar work, such as for cabbage transplanting. Accurate marking-out is very important, because all subsequent operations effected by horse-labour are accomplished so much more effectively and conveniently; especially in the work of horse-hoeing and moulding up. The coulters make sufficiently deep marks to indicate the rows, and of course the coulters must be set at such a width from each as is deemed best. As an average, 27 inches in width is found a convenient distance for the rows of potatoes to be grown. It is found that to mould up potatoes with the ordinary moulding plough it is necessary to have the rows as much as 27 inches apart, though sometimes, where early and small cropping varieties are grown, 2 feet from row to row is all that

is allowed, but in such cases thorough moulding, which would stand washing by heavy rains, is not made, as the potatoes are dug within a very short time, and all that is attempted is to cover in the tubers, which do not occupy so much space as in the case of the heavy maincrop varieties. Heavy cropping maincrop varieties, grown where very thorough moulding is required, are planted in rows 30 or more inches apart. Such a width is also allowed where land is foul, and an attempt at cleaning the land is to be made whilst the crop is growing.

Width of Drills.

Having marked out the land at the required width, the distance at which the potatoes are to be planted from each other along the rows has to be decided. Many points have to be considered, and the width from row to row has to be borne in mind. Strong growing varieties require more space to develop in than do the earlier varieties. At the same time very robust new varieties, with a tendency to grow coarse tubers, have to be regulated so that they produce a more marketable sample, specially large potatoes being unsaleable except to bakers of bread or those who sell baked potatoes in public places. The size of the seed also has an influence, as a bigger plant, or collection of plants, may be expected from large-sized sets than from small seed. Thus, a variety which where sets of full-seed size (rather bigger than a large duck's egg) would be planted at distances of 14 or 15 inches apart, a

distance of 9 inches would be suitable for chats or small seed which pass through a mesh of 1 inch. The manner in which the tubers form about the stem—whether they form in clusters immediately at its base, or singly at a distance from it—affects the question to some extent, as where they spread about there is considerable risk of injury when being dug; consequently, if the sets are very close, there is a certainty that a considerable portion will be pricked. A potato pricked by a fork is injured so much that it has to be discarded from choice samples, and only realises the price paid for offal. Cut seed should be planted slightly closer than whole seed of the same size, as, especially among the white flowering varieties in dry planting seasons, there is a risk of the plants not becoming established, or only weakly so. Potatoes of the Magnum type, which have a tendency to develop a large number of small tubers in proportion to ware, should be allowed more room than Reading Giants, the Wonder, and similar varieties, which produce comparatively few tubers of seed size. The richness of the soil must be brought into consideration, as a poor soil does not grow such robust plants nor produce so large tubers as one which is well manured. Bearing in mind these points, so that variation may be made in accordance with them, it will be found that with fair-sized seed a good average for early varieties in ordinary cultivation is 2 feet from row to row, and 15 inches from set to set; and for later varieties rows 27 inches with sets 15 to 16 apart, or rows 30 inches apart, and sets 14 to 15 inches from each other, will be found most suitable.

Dibbling-in Potatoes.

Having decided upon the distance at which the potatoes are to be planted, the next point to decide is what means shall be adopted in planting them. Where they are budded a dibble is commonly used; this is a stout stick or shaft about 4 feet 6 inches long, at the bottom of which is attached a thicker block, tapering towards the point; the top of the block is cut square so as to form a tread for the foot. The dibble is forced into the ground, and a hole sufficiently large for the set to be placed in it at a depth of about 3 inches below the surface is formed. When the potato is in its place the hole is filled in by means of a rake or harrow. This is a somewhat slow and expensive method, and is only recommended where the sets have been sprouted. Sometimes a dibble consisting of a pointed shaft about 3 feet long, with a T-cross-piece at the top, is used. The T-piece is held in both hands, and the hole is made by thrusting the dibble into the ground by the force of the hands only.

Spading-in Potatoes.

Spading-in is a more expeditious method, as with well-prepared ground a man and boy can plant an acre in a day, with rows 2 feet 3 inches apart, and sets 15 inches from each other. The man goes along the mark, and throws out a spadeful of earth at each place he wishes a set to be dropped by the boy. Having worked across the field he commences on the next row, digging out a spadeful of earth as before, but now

he throws it into the hole dug in the previous row; this covers in the potato, and the planting is complete. When dibbling or spading-in is practised it is important that the soil immediately about the sets is in a well-worked condition; the space between the rows can be stirred by means of grubbers afterwards. One of the advantages of the Ridge system over the Flat is that the land is left in a light condition above the sets, and the whole of the soil is moved after the horses have passed over the ground.

Ploughing-in Potatoes.

Ploughing-in on the Flat is largely practised in some districts, but it is only suitable for strong growing varieties. The chief disadvantages are that, except where the ploughing is very accurately done, and great care is exercised in the placing of the sets, the rows are not sufficiently straight to allow good work to be done with the horse-hoe and grubber. The horses are liable to displace the sets if they are allowed to walk in the furrow, and if they walk on the unturned land they destroy its friability. A distinct advantage is obtained by using the digging plough in the place of the common plough, as the land is left in a much better condition and the work is more economically done. Two furrows made by a digging plough are sufficient to cover in the potatoes, when the rows are placed 27 inches apart, whereas three are necessary where the common plough is used, and the work is not so well done. Six or seven hands are required to

place the potatoes into the proper position when there are as many ploughs employed as it takes furrows to turn the space from row to row. Ploughing-in is sometimes adopted on foul land, where a partial cleaning is intended. In favourable seasons this is attended with success, but it is necessary to grow a very robust variety, which will not be too much checked by the trampling the land is subjected to. Should the season, particularly before the potatoes show above ground, prove wet, the land gets into a frightful mess, and it would have paid far better to have cleaned it in the ordinary way, putting in a crop of turnips to pay the cost of working during that season, following with potatoes in the subsequent year, when the land is in all ways better fitted to carry a crop. Where the crop is taken on foul land in this way, the rows should be placed an extra width apart so as to allow ample room for cleaning after the crop is above ground. The cleaning operations after the crop is planted are necessarily restricted to the stirring of the land above the sets, consequently the sets must be placed deeply in the soil, otherwise they will be pulled out of the rows and be killed in the after workings. A depth of 8 inches is necessary where thorough working is to be adopted.

Catch Crops with and after Potatoes.

Catch crops are often taken with or after potatoes. In districts where early varieties are grown it is not an uncommon practice to plant winter greens between

the ridges some time before the crop is dug. It is, of course, necessary that the moulding-up is completed before this. The plants are put in the ground as soon as the potatoes form, and it is advisable to place a small quantity of nitrate of soda round each plant to help it make a start. When the potatoes are dug the earth is turned back so as to surround the plants. In this way a few weeks' growth is gained, which is a very important matter in the cultivation of winter greens. When potatoes are grown with the view of being dug very early the rows may be placed very closely together, and with the view of obtaining large cabbages subsequently many growers restrict the width of the rows of potatoes to twenty inches, and sometimes less. When this is done the cabbages or greens are planted in alternate rows. This ensures a better crop of cabbages and greater convenience in digging the potatoes. Other growers having in view the winter crops purposely make the rows of potatoes wide, sacrificing a small portion of the potato crop to the green crop, which frequently proves the more profitable of the two. Where the rows are placed farther apart the potatoes are placed nearer in the rows.

Potato Planting Machines.

Several attempts to introduce machinery to aid in potato planting have been made; that invented by Mr. Arter, now made by Messrs. Ransomes, Sims, & Jefferies, has proved very useful. An exceedingly ingenious machine is now turned out. As at present

made two rows of potatoes are planted at once. A hopper is mounted on a frame supported on travelling wheels, which, by means of nave-gearing, supply the motion to the working parts. The hopper is constructed so as to divert the potatoes to the sides. On the axle of the wheel, placed so as to form the outer sides of the hopper, are two revolving cones against which the potatoes rest. Each cone has a series of projections, each of which is fitted with a needle-bar. The needle-bar is fitted with three points; near the middle of the needle-bar are a stud and spiral spring, and at the back of the cone is a fixed cam which actuates the needles. When one of the projections enters the bulk of potatoes the needle is held back by the cam until a potato is driven up to the projection, when it is impaled on the needle and conveyed to the top of the cone to the spout. Here it is released by the cam, which withdraws the needle until it is flush with the cone, the potato falls into a spout which conducts it to the furrow already made by a coulter, to which are attached small adjustable mould-boards, and which is fixed in front of the spout. The distance from row to row can be varied by regulating the spouts or guides to plant from 24 to 32 inches apart, and the distance from set to set can be varied from 12 to 16 inches. The machine is arranged to plant either on the Flat or on the Ridge, with or without manuring. A track wheel is provided which forms a groove in the manure placed between the ridges, and thus ensures that the potatoes drop in a line on the manure.

Two horses are required to work it, and the driver is conveniently seated to drive it, having at hand the regulating lever for controlling the machine. The wheels are adjustable, so that they may be regulated according to the width of the ridges. The machine is under control of the driver, and the only additional labour necessary is to supply the seed to the hopper and to harrow in the seed. From six to seven acres may be planted in a day.

With the view of meeting the demand for a three-row planter workable by two horses the writer has recently brought out a new machine in which he places great confidence. The construction is light and simple, there being few working parts. The potatoes are contained in a hopper divided into three compartments, delivering them into three spouts; at the end of each spout, but not quite touching it, a small receptacle is made to rise and fall so that when at its lowest point a potato falls into it; on being brought to its highest point the potato is met by a shaft carrying a needle, which picks up the potato and conveys it towards the funnel of the spout, which deposits it in a track made by a small mould-board. The potato is released by being drawn against a fixed bar. The potatoes are regulated by simple contrivances which prevent too many reaching the receptacle at one time, yet ensure that one is ready to be picked up on every occasion of the needle coming down. The mould is turned over the set and the planting is complete.

In those districts where there is a scarcity of labour

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SUTTON'S SUPREME.

FLATTISH ROUND SECOND EARLY. WHITE.

Introduced by Messrs. Sutton and Sons.

the machine is a very useful introduction. Whatever method is adopted when planting on the Flat it is important to cover the potatoes sufficiently to keep them from being frozen in the ground. Except in very rare instances no injury is done if there are two inches of mould on them, but it is safer to place them an inch or two deeper. On the Ridge system they are necessarily well covered.

Planting on the Ridge.

So many of the best potatoes are grown on the Ridge system, that being the system adopted in the districts where soil and climate combine to produce excellence in quantity and quality, that perhaps it is entitled to be considered the best method of cultivating the crop ; and we are inclined to favour this view on the whole, though owing to the climate being dry in summer, and the soil being very porous, we find it more suitable to adopt the Flat system in our own district. It is also more convenient as being better suited to the particular work on our farms. The only point in connection with the Ridge system which is a serious objection to it is that it requires such a large supply of horse labour at the time of planting, which proves very irksome in wet seasons. This fault is much intensified by the custom of placing the manure in the ridges at planting time; work which, when the Flat system is practised, is better and more conveniently done at less busy seasons. This, however, is a matter which will be dealt with in the section relating to

manures. A feature in favour of the Ridge system is that less work is necessary after the planting is completed, and the division between the soil and the subsoil is kept definitely by the layer of dung, thus rendering it easier to plough out the crop when ripe. The two ploughings at the time of planting are advantageous because the land is thoroughly lightened during the operations. When the land is taken in hand in spring it may be necessary to clean it, when the ordinary operations of cleaning have to be carried out. Just previously to planting the land is laid up into ridges by means of a double-breasted plough. The ploughs have to be adjusted so that the ridges are at the required distance apart, as this cannot be regulated subsequently. As a rule it is advisable to proceed with the work of planting immediately after the land is ridged, but the circumstances of weather and the dryness of the land, together with the natural characteristics of the soil itself, have to be considered; these sometimes necessitate its being left for some little time. The manure is then carted on to the land and spread along the furrows at the required thickness. As soon as the dung is in position the potatoes are laid on it, and the moulding plough splits the ridges so that they are re-formed where the furrow had been. This covers in the potatoes, and the operation is complete. Dung is not always applied at the time of planting, when, of course, the operations are more speedily performed. When dung is applied in autumn or winter the preparations for planting are

the same as in the case of the Flat system. When artificial manures, other than the quickly acting nitrogenous ones, such as nitrate of soda, are applied, it is usual to sow them at the time of planting so that they lie close to the sets. The incorporation of manures with the soil previously to planting always appears most satisfactory in our experience.

Potatoes in Gardens.

When potatoes are planted in gardens they usually receive more care and attention than is given them when grown on a large scale in the field. The endeavour is to grow a maximum crop, very often not strictly with the view of the greatest profit. Manure is applied lavishly, and the soil is cultivated to a great depth. These operations, however, must not be looked upon as being entirely wasted, as garden cropping is more intense than field cropping, a larger number of crops being taken off the land; in fact the land is rarely idle. The potato requires liberal manuring, but in rich gardens which have been generously treated for a number of years with farmyard manure it is often inadvisable to put on a heavy dressing for the crop; but better grown tubers of higher quality are often obtained in old gardens by the application of lime, in which such gardens are frequently deficient. As the land in the garden is so closely cropped, it is not always convenient to get the ground dug very long before the potatoes are planted, but it is to the advantage of the crop to have it broken up as

early as possible. If no crop is grown through autumn it should be dug then: if a spring crop is taken it is obvious that it cannot be dug during winter. On ground which rests on a close subsoil it is advantageous to trench the land so as to afford more thorough tillage, but on loose subsoils equal advantage is not gained, although the land may be benefited to some extent. Potatoes of more even quality are obtained when the trenching and manuring are done for the previous crop, thus avoiding the necessity of putting the potatoes on the dung. A small quantity of mineral artificial manures or lime is then all that is required, and if the land is dug a spit deep no treatment can be better. The potatoes can then be planted on either of the systems already mentioned.

Jersey Potatoes.

The Channel Islands are favourably placed for the production of potatoes early in the season. Until very recently these and the Scilly Isles were practically the only places outside England from which considerable quantities of new potatoes were imported before June. Other countries now compete for the high prices which rule early in the season, but Jersey is still the most important producer. Jersey maintains its high position not only on account of the earliness with which the potatoes can be put on the market, but because of the high quality of the produce, due to good cultivation and the selection of varieties suitable for the special trade. Over 50,000 tons are exported

yearly, every available piece of ground being planted with potatoes. Mr. E. Le Bas, of Le Bocage, St. Peters, has kindly supplied me with many points of interest in connection with his method of growing the crop. Although there are instances where the land has been cropped with potatoes for twenty or thirty years without a break, a great proportion of the land is worked under rotation, grass, potatoes, and corn being grown. As, however, the manuring is heavy, the necessity of strict rotations is not of greatest importance. When potatoes are taken after grass seeds the land is pared about two or three inches in depth in November. In January the furrow is broken by harrows, and a heavy dressing of dung is applied; this is ploughed in with a furrow from 10 to 18 inches in depth, the usual depth being from a foot to 16 inches. Planting commences in the first week in February and is finished in the first week in March. The land is laid up in small ridges about 14 to 18 inches apart, and into this the artificial manure is sown. The sets are placed in the furrows about 10 inches apart. On an average Mr. Le Bas finds that 25 cwt. of Myatt's Ashleaf, 22 cwt. of Snowdrops, and 35 cwt. of International Kidney are required per acre; but the quantity varies considerably in accordance with the size of the seed. The seed is sprouted before it is planted. In September it is placed in shallow boxes in potato-houses and kept cool to prevent too early sprouting. The seed is placed with the rose end uppermost, and at planting time it is desirable that the shoots are about an inch

and a half in length. Seaweed is put on the land in autumn, where available. From 15 to 25 tons of farm-yard manure and from 8 to 12 cwt. of artificial manure go to make an ordinary dressing, though more is given in some instances. Nitrate of soda, sulphate of ammonia, superphosphate, and kainit are used. Mr. Le Bas uses dissolved Peruvian guano with an analysis of 8 per cent. of ammonia, 20 to 22 soluble phosphates, and 1 to 1½ potash.

When the crop is up it is kept clean by hoeing, and by the time the plants are four or five inches high they are moulded up lightly. The digging commences in some parts of the island early in May, and in the open districts a week or fortnight later. Those grown under glass are placed on the market in April and fetch 6d. per lb., while those dug earliest in May fetch 3d. per lb. or 25s. per cwt. The prices fall rapidly when the digging becomes general, but throughout May the price generally runs as high as £9. From this onward the price gradually falls, until in the middle of July, when they have to compete with English grown potatoes, they realise only 70s. to 80s. per ton. The yield varies from 3½ to 5 tons, in the case of those dug early, to 11 to 18 tons for the main crop allowed to grow out. The earliest are grown on sandy soils. Good rich loam produces the heavier crop. Heavy soil is latest and most liable to disease. A change of seed is generally obtained in the case of Myatt's Ashleaf and the Snowdrop, this being obtained from England.

The Jersey method of early raising has been adopted

in parts of England where circumstances permit it, and even so far north as Glasgow it is successfully carried out, though the milder climate of Jersey gives the growers there the advantage of being the first to place their potatoes on the market. Frost is the great hindrance to the general adoption of methods which would permit the earlier production of potatoes in other districts.

Two Crops in One Season.

Two crops of potatoes are occasionally obtained on the same land in one season. This, however, can only be done in very mild climates, or where the frost is kept from them by artificial means. To secure the double crop early maturing varieties are necessary. The seed for the first crop should be budded or sprouted by being laid out singly in a warm shed early in December; in January the sprouts will have attained sufficient length for the sets to be planted out. This must be done carefully, so as to keep the young shoots uninjured. In a warm situation the crop may be dug in May or June, and the preparation for the next crop should at once be proceeded with. The seed for the second crop should be kept in a cool shed, and be laid singly on a shelf or floor. It is probable that the sets will have been weakened to some extent by the shoots, so close planting should be adopted. With such varieties as the Ashleaf, a foot from row to row and 8 inches from set to set will be sufficient, but more robust varieties may be planted at greater distances. If new potatoes are

desired at Christmas, the planting of Ashleaf may be deferred until July. Two crops may be obtained in exceptional seasons without quite such close attention, but there is always a risk, and the practice can hardly be recommended, as it is usually more profitable to take an after-crop of winter greens.

The Season for Planting.

The season for planting depends on the climate, soil, variety, and markets available. Treating with out-of-door culture, climate is the first consideration. The frequency and severity of spring frosts control the time at which early varieties may be sown. Latitude does not entirely control this, as inland districts suffer more from frosts than do those near to the sea. The West coast of Great Britain and Ireland possess an earlier climate than is found at similar latitudes on the East coast, because they are more affected by the Gulf Stream; but even on the East coast the climate is less severe than it is inland. Low-lying districts are more liable to frost than are those at slightly raised elevations. This is shown every year when there is a severe spring frost; very often when the lower half of an almost flat field is withered the upper portion is so slightly affected by frost as to receive no check. Large open valleys, like the Ouse valley, are very susceptible to these spring frosts, especially, too, in those parts far inland, where the sea has little effect. From Cornwall, by Cheshire, and on to Glasgow, early planting is adopted, because the climate is tempered by the ocean. As showing what

effect elevation from the ocean has on the weather, the thermometrical readings at Cambridge are lower in January than are any other readings between that place and Nairn in the northern part of Scotland. More serious than spring frosts are summer frosts, which fortunately are rare, but the frosts on the 14th of June, 1892, and on the 20th of May, 1894, are remembered by most growers. The June frost was most serious in its effect in the early districts—the tubers were just forming, the plants had lost their most robust growth, and there was so little opportunity for new growth to be set up, that the stricken crops were rendered almost useless. The May frost extended over a much greater area, affecting the crops in all the low-lying districts throughout Great Britain and Ireland.

Effect of Soil on the Season for Planting.

The soil affects the planting season in two ways. It is necessary that the land shall be got into a friable condition, and this is, of course, more easily done where the land is naturally light and well drained than where it is heavy and wet. Some land retains warmth and supports growth more readily than does land of a different nature. The presence of a good local market, such as is found in proximity to large and wealthy towns, where high prices for new potatoes early in the season are readily given, is an inducement to growers to plant early. The variety planted, of course, also has to be taken into consideration. As bearing on the question

of season for planting potatoes of varying types, the following remarks on an experiment conducted by ourselves, and communicated to the Journal of the Royal Agricultural Society, third series, Vol. 2, Part IV., by Mr. George Malden, show that there is much to be borne in mind :—

EXPERIMENTS IN THE PLANTING OF POTATOES.

Certain statements as to the advisability of the late planting of potatoes having appeared in some of the daily papers, and being at direct variance with our personal experience in the cultivation of potatoes on a large scale, it occurred to us to conduct some experiments on our farms at Cardington in order to find what would be the exact result of such an investigation.

With that idea one side of an open field, which had previously been prepared for potatoes, and upon the remainder of which a crop of Imperators was subsequently grown, was set aside. The land was excellently adapted for the requirements of the crop, being well drained and of a uniform description of light oam, resting on a gravel subsoil. An even dressing of about 15 tons to the acre of good farmyard dung had been put on and ploughed in during the autumn, and the land remained untouched through winter. In the early spring the field received a thorough working, and was brought down to a deep tilth. Drill-marks two feet apart were made right through the land which had to be subsequently planted, and plots of one pole each were carefully marked off.

The fourteen varieties of seed potatoes selected were of the ordinary seed size and had been grown on the farm in the previous year ; they included those most favoured by growers and salesmen as well as others not so well known. The Thorburn is an American variety hardly distinguishable from the Beauty of Hebron. The Duke of Albany is of a type to which

the Puritan and White Beauty belong. The Village Blacksmith, though now recognised as of no value as a field potato, created a sensation some three or four years ago by its peculiarly dark and netted skin. Daniels' Advancer, The Daniels, and Empire State have all done well with us, the two latter being of special quality. Future Fame, Stourbridge Glory, and The Bruce are varieties very similar to the well-known Magnum Bonum.

After the first planting, the seed was turned over every other week and the sprouts were destroyed in order not only to prevent them from heating and exhausting their vigour, but also to ensure that the different plantings should start their growth on equal terms. Otherwise, had some been planted with unbroken sprouts, it is quite possible they might have been above ground as soon as those planted a month earlier. Though the seed, generally, of the earlier varieties is often sprouted and greened for forcing under garden cultivation, it is practically impossible, owing to the want of space and care required in handling, to effect this on a large scale in the field.

Though the year was generally regarded as a disease-year throughout the country, the weather suited the potato crops in the South Midlands, and there was no more than an average amount of disease in this district (Bedfordshire), so that good crops were the rule rather than the exception. The rainfall, though spread out in many showers during June and July, was below the average, and the weather was exceptionally fine after July 20.

The first planting was done on March 31, two poles of each variety being spaded in. After an interval of a month another planting took place, a similar quantity of each of the fourteen varieties being again spaded in. All that was done to the land, in addition to what had been done previous to the first planting, was to run the horse-hoe up the drill-marks. This was only fair, as otherwise the land would have become somewhat set, and the potatoes would not have gone in so well at the later as

at the earlier plantings ; for this reason the horse-hoe was also used before each of the other plantings. After another month —namely, on May 31—another planting was made of all the varieties, but this time and subsequently only one pole of each lot was planted. A fortnight later twelve of the fourteen varieties were planted ; and still another fortnight later—namely, on June 28—the last planting was done, and ten out of the fourteen varieties were set. It will be shown subsequently that the plantings were carried late enough for the purposes of the experiment. The potatoes were horse-hoed, hand-hoed, and moulded up in the usual manner, as soon as the crop was sufficiently forward.

The earlies were planted at 24 in. from row to row by 18 in. from set to set ; whilst the mid-earlies and main croppers were given a larger space in which to develop—namely, 24 in. between the rows and 21 in. between the sets. The potatoes were regarded as ripened when the stems had entirely died down and no sap remained. As it is practically impossible to fix this to a day or two on some scores of sets, the date put down was that of the next Saturday after the first day when no life could be perceived in any of the stems on the plot. It will be noticed that though the plantings occupied a period from first to last of 12 weeks 5 days, the greatest difference between the time of ripening of the first planting and that of the last planting of any one variety was only six weeks, and this occurred in the first earlies alone. Of the mid-earlies only one plot (White Elephant) made a difference of as much as five weeks, and the longest interval on the main varieties was but four weeks, and that on one variety (The Bruce) alone.

It seems only reasonable to expect the best results from those plantings that had the longest time to develop in the ground, and this is almost invariably the case ; for we find that of the 14 plantings made on March 31, 13 yielded more than those planted a month later, whilst the fourteenth (Myatt's Ashleaf)

produced an equal bulk. Of the same number planted on April 30, 13 again were in excess of those planted on May 31, and one (White Elephant) less. Of the twelve varieties planted on May 31 and June 14, the whole 12 planted on the earlier date yielded more than those planted later, and the whole of the 10 varieties planted respectively on June 14 and June 28 yielded more on the first than on the second planting. So, in comparing these fifty instances of an earlier with the next succeeding planting, we find that no less than 48 yielded heavier crops, one an equally heavy crop, and only one a less crop—the weight including both seed and ware.

That the date of the last planting, June 28, was backward enough was proved by the very poor result obtained, the average weight for the whole lot being very little over 26 cwt. per acre, or not twice the weight of the seed originally planted. In some cases, notably those of The Bruce, Magnum Bonum, and Imperator, they never grew with sufficient vigour to prevent their ripening before those planted a fortnight earlier. We find that the average weight per acre of those planted on March 31 was about 19 cwt. in excess of those planted a month later. 46½ cwt. above those planted on May 31, 69½ cwt. more than those planted on June 14, and no less than 105 cwt. in excess of those planted last of all. Putting their average value, one season with another, at the somewhat low figure of 50s. per ton, the first planted exceeded in value the second by £2 7s. 6d., the third by £5 16s. 3d., and the fourth by £13 2s. 6d. per acre.

It is often more or less impracticable to commence planting largely before the latter end of March, but these results point emphatically to the necessity of getting the potatoes (particularly the earlier varieties) in by the end of April, for though the falling-off of 19 cwt. per acre is considerable, yet up to that time there is still a prospect of tolerably good yields; but the further fall to 46½ cwt. of those planted on May 31 puts out of the question all idea of a profit from those planted so late in

the season as the last week or two in May, the average of all varieties having fallen to about 84 cwt. per acre, and the later varieties, under these circumstances, doing very much better than the others. But it was from the subsequent plantings that by far the greater proportionate drop took place, the yield of those planted on June 14 falling to 61 cwt., and, as before stated, to 26 cwt. from the last planting.

The four first earlies planted on May 31 averaged rather less than 67 cwt. per acre ; the four second earlies—excluding those light croppers the Village Blacksmith—averaged rather over 83 cwt. per acre ; and the five main croppers averaged slightly in excess of 111 cwt. As there is no prospect of earlies, or even of second earlies, planted so late, maturing sufficiently early to catch any special price either when fully matured or when dug green, these results would show the necessity of planting a main-crop variety when it is imperative to plant at all so late in the season, as under hardly any conceivable circumstance can a crop of 67 cwt. be expected to pay, whereas 111 cwt. per acre, the yield of the late varieties, should not be a losing crop.

Again, taking the plantings made on June 14, the average yield of the first earlies had fallen to a little under 39 cwt., the second earlies to 59 cwt., and the late varieties to 85 cwt. None of these average results can pay ; but one variety, the Imperator, gave the extraordinary yield of 134 cwt. per acre—more than 2½ tons in excess of any other variety, and which, had it not been for the good results we have repeatedly obtained with this variety from late plantings (for instance, last year we planted twenty acres of them after May 20, which averaged 7 tons per acre all round, and in some places ran to more than 8 tons), we could hardly have believed to have been possible. The poor results obtained from every variety of those planted on June 28 show planting at that time, under any and all circumstances, to be totally out of the question.

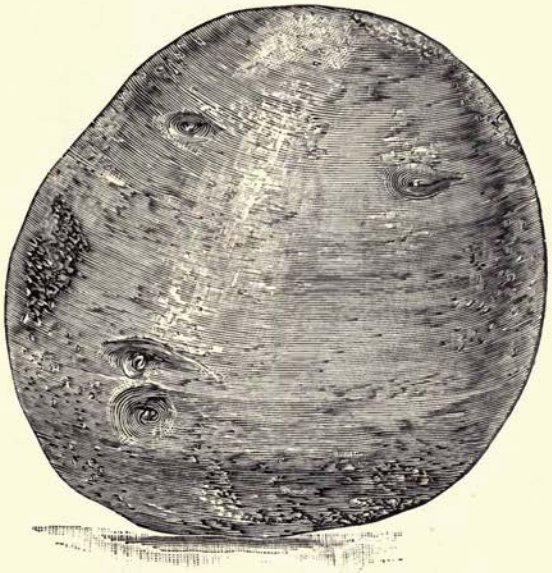
The foregoing results, although detailed for one season only

are thoroughly in accord with our experience as growers, for many years, of more than one hundred acres annually. We may conclude, therefore, with the following advice to growers: Plant the early varieties of potatoes in March, or as early as possible in April. Finish planting all varieties in April; but, if it is necessary to plant in May, by all means employ a late variety.

The trials thus reported on were complete, and they indicate the planting season most suitable for the three different classes of potatoes in the central part of England. They have a bearing on all districts, as showing relatively how early and late planting influence results.

When there are so many points to be considered in the matter of planting, it is obviously impossible to fix a hard and fast date for planters to commence their work; it must be largely influenced by local climate. The best guide, as a rule, is local practice, as this is founded on experience in the vagaries of the weather throughout a long period. This is not always correct, but with a little observation and inquiry it is possible to form a pretty safe notion as to the proper season to commence and leave off planting. From January to May affords great latitude, but in parts of Ireland, Cornwall, Cheshire, and other places. where the weather is mild throughout spring, sprouted sets are planted in January, though these are so exceptional as to constitute but a small section of the crop. Fine, dry weather in February is largely taken advantage of,

and the greater portion of potatoes are planted from mid-February to mid-April, though, owing to the difficulty in getting land into condition sooner, it is probable that half the area under potatoes is planted after the middle of March.



EARLY MARKET FAVOURITE.

FIRST EARLY WHITE ROUND.

Introduced by Messrs. Malden Bros.

SECTION IV.

MANURING.

Farmyard Manure.

Profitable potato growing is closely connected with the ample application of manures. The mainstay of market gardeners has always been farmyard manure, with which is included town, stable, and others of similar nature. As a rule, what is known as London dung is quite as rich in manurial properties as the best farmyard manure. The preference for farmyard manure—or, as it is more commonly called, dung—by market gardeners is not solely due to its manurial constituents, but to the beneficial effect it exerts on the soil. Market garden soils, and such soils as are best suited to the growth of potatoes, are usually of an open nature, and thus easily influenced by drought, and to a less degree by excessive moisture in seasons when the rainfall is heavy. Heavy dressings of dung help to retain moisture in dry seasons, and keep the soil open and thus promote free drainage in times of too plentiful rains. The surface, too, is less likely to become set or capped after heavy rains. The mechanical effects of dung are quite equal to the manurial, and must be taken into consideration when estimating its value

in comparison with other manures. In seasons when there is a fair amount of sunshine and shower, such as keep the soil in a favourable condition of moisture, the advantages of dung are not so plainly marked. Unfortunately our climate is not so genial as could be desired, and years when it is favourable are so conducive to the growth of potatoes that such heavy yields are obtained that prices are proportionately low and unremunerative. The years when the crop is most profitable are those in which the yield is light, and the proportion of potatoes of good quality is small. Nothing has so injurious an effect on the quality as a check during growth after the tubers have commenced to form. When this occurs the portion of the tuber which forms subsequently is never of the same quality as that which had formed previously, and the cooking properties are spoiled. In addition to this the outward appearance of the potato suffers, as in the case of kidney varieties it assumes an hour-glass or dumb-bell shape. Round potatoes develop protuberances which are unsightly, and denote inferior quality. In the production of potatoes possessing good quality there is nothing so important as to keep the tubers steadily increasing in size; consequently, the value of a good supply of dung in the land cannot well be over-estimated.

The land is more readily worked to a proper state of friability when it contains dung. The particles of soil hang together less tenaciously when there is a supply of vegetable matter in it. This lessens the

expense of working it, and it is brought into a good condition when it is required for planting; whereas, otherwise, the season might have advanced so far that the planting might have to be delayed longer than is desirable—this occurs frequently.

A dressing of dung has a lasting effect on the land, as neither the mechanical nor the manurial properties are exhausted in one year. This, of course, is not lost sight of by growers, particularly by those who grow other special crops, though it is by no means disregarded by those who grow ordinary coarse crops after potatoes.

The cost of dung as a manure is heavy in comparison with that of those which exert their influence in one year and are of little value afterwards. The greater liability to disease which accompanies potatoes grown on dung is another objection to its use. As a rule, however, this special proneness to disease is shown most strongly where the potato actually rests on the dung, or the dung has been but recently applied. The earliest experiments carried out with the view of preventing disease showed that the dung increased the liability and virulence of the attack. The recently conducted experiments at Warminster support this view, and general experience confirms them.

The profitable use of dung in the place of artificial manures must be considered from all points of view. The cost, ease of application, less liability to cause disease, and quickness of return are in favour of artificial manures. The small cost of dung made on

the farm, the better quality of the tubers, especially in the event of a droughty season, the better working of the land for a number of seasons, the improved drainage, and the long period for which the fertility of the land is maintained, go to the credit of the dung.

The Application of Farmyard Manure.

Farmyard manure should be put on the land in autumn or winter when convenient, so that it may become incorporated with the soil, and be able to exert its mechanical and manurial influences when they are required. Manure applied in spring frequently hinders rather than advances the tillage operations. When applied in the furrow, where potatoes are planted on the Ridge, the only hindrance is that of its application; this is a serious one, as good weather, which might be advantageously availed of, has to be given up to the carting and spreading of the dung, but otherwise the tillage work is not interfered with. When applied in the autumn the dung should not be decomposed too thoroughly, or much of its value will be lost through the soluble portions being washed out of the soil. Nor should it be too fresh, or the manurial constituents may not become available for the plant until late in the summer. This is particularly the case where the potatoes are to be dug early. It is the availability and not the mere presence of the manure in the soil which makes it valuable to a particular crop. The rottenness of the

manure should be regulated as far as possible to the season at which it is applied and the period at which the potatoes are to be dug. When dung is applied in the spring it is obvious for all reasons that it should be allowed to ferment thoroughly previously to its application. Decomposition is caused by fermentation, and the dung should be induced to ferment as much as possible by being thrown up into heaps, care being taken not to tread upon it, as pressure retards fermentation.

The Quantity of Farmyard Manure Applied.

The amount of dung required to produce a full crop of potatoes varies according to the condition of the land. If naturally rich, and a large quantity of cake has been fed upon it, together with a heavy crop of swedes, it is quite possible that no manure at all is required, except it is desired on account of its mechanical influence. Dressings of from 20 to 40 tons per acre are commonly applied in strictly market-garden districts, but of course it is intended to take other exhaustive crops subsequently, and these will benefit from the residue left in the land. On light sandy soils 50 or even more tons have been applied. Before the development of early potato culture in the warmer climates of the Scilly Isles, Madeira, Malta, Egypt, and when the Channel Islands grew fewer, English growers of early potatoes obtained the high prices commanded by new potatoes, which unfortunately they do not get now, as, except in favoured

positions, the foreigner steps in and supplies them when they are highly remunerative to the grower. Many acres of poor sandy soils, valueless for other purposes, but which at one time ranked among the most remunerative for early potato culture, have now gone out of cultivation because it no longer pays to cultivate them for that purpose. On the Greensand near Potton, in Bedfordshire, is a considerable tract of this kind. On this dressings of London dung, from 40 to 60 tons per acre, were applied, solely to produce early potatoes. The soil is almost completely composed of sand, and the manurial and mechanical properties of a fertile soil had to be placed in it, and for this purpose dung was most suitable. It now grows gorse and fern.

From 20 to 30 tons of dung is a good dressing per acre on land in moderate condition. London dung, 50 miles by rail and a mile cartage into the field, costs from six to seven shillings a ton to put on the land. The dressing is therefore expensive. Home-made manure saves the cost of railway carriage, and if the cattle which have manufactured it have paid a good profit for feeding, the cost is light. If, however, the straw from which it was made was grown at a loss, and the cattle did not pay for feeding, it is expensive.

Chemical Constituents necessary to apply.

The cost of dung is that for which it can be made or purchased. It cannot, however, be put at less than five shillings per ton on the land, even under the

most favourable circumstances. Artificial manures can be obtained which supply the manurial requirements of the crop at less cost than when they are in the form of dung. Under most circumstances it is more profitable to use the two in conjunction than either one singly. The average composition of a 6-ton crop of potatoes, with 18 cwt. of haulm, has been estimated as follows:—Of ash in tubers 126 lbs., of ash in haulm 50, total 176 lbs.; of nitrogen 47 lbs. in tubers and 20 lbs. in haulm, total 67 lbs.; of sulphur 2·7 and 2·1, total 4·8 lbs.; of potash 75·4 and 1·1, total 76·5 lbs.; of soda 2 and 2, total 4 lbs.; lime 2·9 and 22·7, total 25·6 lbs.; of magnesia 5·7 and 12·4 lbs., total 18·1 lbs.; of phosphoric acid, 24·1 and 2·7, total 26·8 lbs.; of chlorine 3·5 and 1·9, total 5·4 lbs.; of silica, 2·9 and 2·1, total 5 lbs. In heavier crops the quantities would be proportionately increased. Nitrogen, potash, lime, and phosphoric acid are therefore present in greatest quantity, and must be supplied. These are supplied in dung, though all fertile soils contain them in some quantity.

The following analyses were made by Dr. Munro in connection with the Warminster experiments, and are specially valuable for the remarks which accompany them. The "Potato Manure" mentioned was a special compound purchased.

SOOT.—The sample of soot contains:—

Moisture	5·92		
Organic Matter ..	68·68	containing	Nitrogen 5·17
Mineral Matter ...	25·40	,,	Phosphoric Acid 0.30, and Potash 0·86.
	100·00		

Considered as a potato manure, soot is relatively deficient in phosphates and potash, and on some soils this deficiency would show up in the crops when compared with a complete manure.

KILN DUST.—The sample of kiln dust contains:—

Moisture	10·30	
Organic Matter ...	79·95	containing Nitrogen 3·98
Mineral Matter ...	9·75	,, Phosphoric Acid 0·93, and Potash, 1·80.
	100·00	

The same remarks apply to this as to the soot. The kiln dust, however, contains less nitrogen, and this in a less active form.

GUANO.—The sample of guano contains:—

Moisture and Volatile Matter ...	43·25	containing Nitrogen, 5·24
Mineral Matter	56·75	
	100·00	

Earthy or Insoluble Phosphates	26·70 or Phosphoric Acid 12·23
Soluble Phosphates ...	... none
Potash	... 1·15
Magnesia	... 4·70

On most soils it would be well to add potash salts to the guano for potatoes.

"POTATO MANURE."—The sample contained:—

Moisture	14·16	
Sulphate of Ammonia ...	11·54	containing Ammonia 2·97, Nitrogen 2·4
Phosphate rendered soluble.	17·68	or Phosphoric Acid 8·10.
Potash	2·70	

Such a manure would be obtained by mixing one part of sulphate of ammonia with seven parts of

mineral superphosphate and two parts of kainit. In intrinsic value it is decidedly inferior to the complete manure recommended and used on most of the plots.

COMPLETE CHEMICAL MANURE.—It only remains to add that this manure, composed as it is of equal weights of mineral superphosphate, kainit, and nitrate of soda (or its equivalent of sulphate of ammonia), contains:—

Nitrogen	5·20 per cent.
Soluble Phosphoric Acid ...	4·0 to 4·25 per cent.
Potash	4·0 to 4·5 per cent.

The "Complete Chemical Manure" is that recommended by Dr. Munro, which he advised should be applied at the rate of 4 cwt. of each of the three manures mentioned per acre. The excellent results obtained on the soils for which the mixture was recommended was proved by the fact that several of the late varieties yielded at the rate of upwards of 20 tons per acre. The Warminster soil was reported as being a free working sandy loam with fair reserves of fertility. Of course every care and attention was bestowed upon the crop to make it yield so abundantly, but the fact remains that the exceptionally heavy return was obtained on an average soil by the application of the mixture in the proportions given here.

Seaweed is very valuable where obtainable. Kainit is a good substitute otherwise.

Properties of Artificial Manure.

Superphosphate of lime is found to be a very useful

manure in some instances, particularly on soils rich in organic matter, such as those in the Fens. Even on soils containing less organic matter the beneficial effect is noticeable, and as much as half a ton per acre is sometimes applied. Superphosphate, kainit, and other non-nitrogenous manures are most effective when sown early in the season.

Nitrate of soda and sulphate of ammonia are highly valuable sources of nitrogen. Their action is very rapid, and if heavy dressings are applied they should be put on in two applications—the first when the crop is appearing above ground, and the second just previously to moulding up.

The application of large quantities of kainit is said to deteriorate the quality of the tubers, causing them to be watery rather than floury. This, however, should not altogether deter growers from using it, as if the soil is deficient in potash it is absolutely necessary that it should be applied.

Soot varies very much in its manurial properties, as it is liable to adulteration. House soot is almost distinct from factory soot. Soot such as that analysed above is very valuable, and is obtained from house chimneys. Factory soot contains a much greater proportion of mineral matter, or valueless dust drawn into the chimneys and flues by powerful blasts. Such soot often contains less than half the nitrogen found in house soot. Soot is very frequently adulterated, as it lends itself to adulteration very readily. When soot is bought by weight heavy dust or fine sand is mixed

with it; when bought by measure hair and other light substances which prevent it settling heavily are added. The only safe ground on which to purchase is by analysis, and the amount of nitrogen present regulates its value. Good soot exercises a beneficial mechanical influence on the soil, and this is felt for some years after its application. The high regard in which soot is held by market gardeners is largely due to the mechanical property it possesses of making the land work more kindly and of retaining moisture. From 40 to 100 bushels of soot are commonly applied to land cropped with potatoes.

Lime is necessary for the crop, and if it is not present must be applied. Insect attacks are not so common on land well supplied with lime as on that where it is deficient. It should be applied in autumn or winter, when the land lies fallow.

Manurial Requirements of the Soil.

Land which has been farmed under ordinary conditions generally contains a considerable amount of vegetable matter or humus, consequently artificial manures have a striking effect on it; but if the land is subjected to a system of cropping which exhausts this, the effect is less marked. The beneficial effect of dung is also less marked on land rich in humus. To make a definite statement, giving a mixture which is suitable alike to all soils, is out of the question. The matter must be treated broadly, and each case considered on its own merits. The solubility of the dung has been

shown to influence the extent of its effect on a crop, and fresh long dung, applied late in the season, does little to benefit a crop of early potatoes. In the same way a concentrated manure, in which the constituents are but slowly available, is of less value to a crop of earlier than to a crop of late potatoes. The farmer should know from previous observation in what condition his land is, and must make his calculations accordingly. Twenty tons of dung cost, at least, £5, and frequently £7 per acre. Dr. Munro's mixture previously mentioned costs for the 12 cwt. £3 10s. But larger dressings of dung are frequently given, thus increasing the cost. Under most conditions we favour the use of a mixture of dung and artificials, and, taking all points into consideration, think a dressing of 15 tons of dung and 6 cwt. of the mixture of artificials the most economical method to adopt. This gives a good full dressing, at a cost of from £5 10s. to £6 10s. per acre, in which a reasonable proportion of mechanical and manurial influences are brought to the aid of the crop.

M. Girard has recommended a dressing suitable for a naturally fertile soil, which, converted into cwts., is 5·6 cwts. of superphosphate, 9·6 cwts. of kainit, and 1·6 cwt. of nitrate of soda, together with from 11 to 13 tons of farmyard manure. Taking the smaller quantity of dung at 5s. per ton, the cost of this dressing would be £6 per acre, while the heavier dressing of dung at 7s. per ton would make it £7 16s. per acre.

Soaking Potatoes in Manurial Solutions.

From time to time sensational results of experiments are placed before the farmer with the intention of attracting personal attention, or for other more vague reasons, which, on being tested, proved to be valueless. The advance made in scientific knowledge, as applied to agriculture, has fortunately been so great that when wild theories are advanced they are soon disproved. It was owing to the fact that any theory brought forward, no matter how scientifically unsound the theory was, found advocates, who urged these strange practices on to farmers, that farmers were obliged to be prejudiced against any new discovery, as so much held out to them was erratic. This has changed now, and if a theory is not sound it is soon thrashed out, and its weaknesses exposed. Such a theory was one advanced recently. It was urged that by soaking potato sets in a solution of sulphate of ammonia and nitrate of potash the yield would increase to a phenomenal extent. A series of experiments tried at Warminster showed that harm rather than good was done. There was nothing in the theory advanced to support the idea that such results as were promised should be obtained.

SECTION V.

SEED.

Management of Seed.

The management of the seed or small tubers set apart for seed purposes is a matter of importance. It is advisable to separate the seed from the ware or marketable portion of the crop at the time the potatoes are dug. In this way they are brought under easy control to be dealt with subsequently. The price realised for very early potatoes occasionally induces growers to send everything—ware, seeds, and chats—to market, but as a rule the seeds and chats are retained. When dug the seed should be allowed to dry before being pitted, but if risk from frost is entailed by leaving them exposed during night they should be gathered up and pitted on the day they are dug, even though they are somewhat moist; but they should be closely watched, so that in the event of excessive fermentation setting up they may be turned.

Seed of early varieties should be turned during autumn or before winter. It may be necessary to turn it very shortly after it is dug, or it may not require turning until Christmas. Whenever the seed forms part of a crop in which there was disease at the time of digging it should be looked over within a few

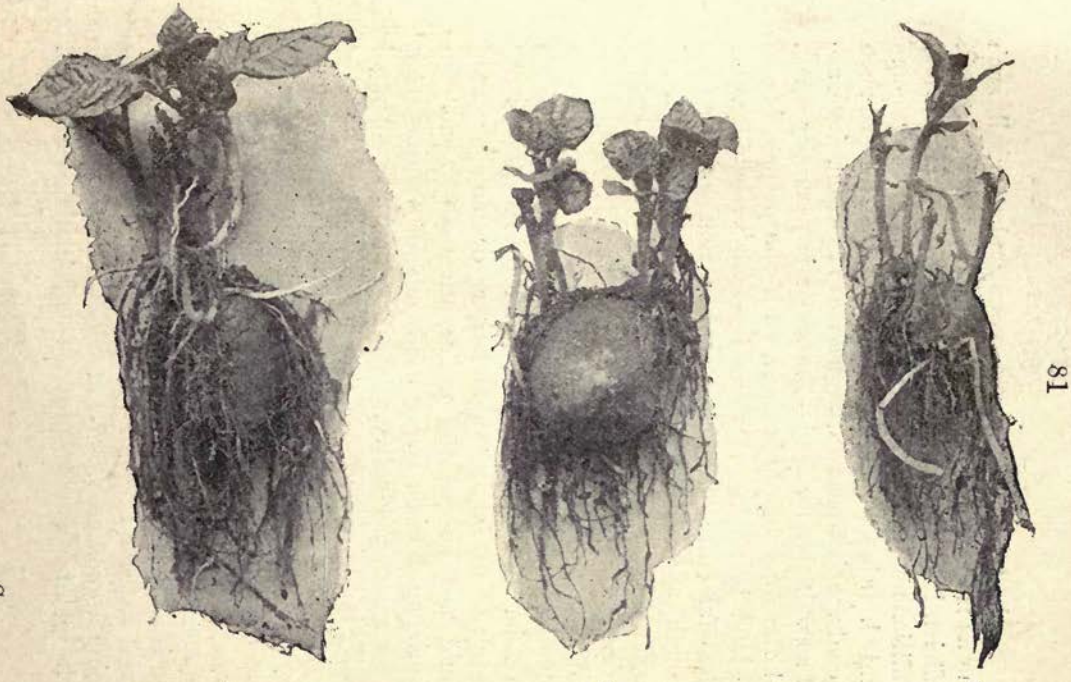
weeks, or, owing to a large quantity of tubers which may have become putrid, fermentation may be set up, which will involve decay in those which would otherwise keep sound. It is especially important in connection with seed of early varieties in years when disease is rampant, that all care should be taken to preserve the seed. The seed of early varieties is always dearest after a disease year because so much of the seed rots in the pits. For all general purposes the seed, if properly attended to, will keep sufficiently well when pitted, but in particularly mild winters the warmth induces sprouting in the pits. As this tends to weaken the sets it should be avoided by turning them sufficiently often.

When the turning is being effected the sets should be examined, and all that are not true to variety or are in any way diseased should be put aside. That which is too small for seed purposes should be taken out by being passed through a 1¼ in. sieve. These small tubers, too small for planting, except when the variety is very scarce, are called chats, and should be given to pigs or poultry, but it is advisable to cook them before using them as food. When the seed is thus prepared there is little hindrance at the planting season. When the sets are sprouted, previously to being planted, they are placed on shelves or other convenient positions, such as the floor in warm buildings, where they produce their shoots, and can be handled without destroying the young growth.

Size and Quantity of Seed.

Numerous experiments have been carried out to ascertain what size seed proves most profitable to plant. Carefully recorded experiments were carried out with this view in Ireland, more that sixty years ago, and M. Girard published details of experiments carried out last year in France; many others have been recorded between those dates, but it does not appear that they have adduced more than that a medium size whole potato is likely to grow the best crop. The tubers which pass through a sieve with meshes 2 in. apart, but which will not pass through meshes 1½ in. apart, are most profitable to plant; they are not quite large enough to go into the best samples of ware, and are consequently not of highest value. They are not extravagant in the weight of seed required to plant an acre, yet they produce plants which, if fairly treated, yield a profitable crop of tubers. The size of the seed likely to prove most profitable is regulated by the treatment of the soil. On roughly prepared ground in poor manurial condition a small seed has but a poor chance of thriving, particularly if the weather is very dry for some little time after planting; but on well tilled land in good condition the same seed may, under favourable climatic conditions, produce as good a crop as would be obtained from seed of much larger size.

The growth of the plant in fact is largely dependent on the condition of the land. The seed is required



Photographs of three young potatoes adjoining each other, in same soil, and grown from (A) 4 oz., (B) 2 oz., (C) 1 oz. sets; showing extra vigour of shoots from larger sets. Fig. II.

to supply nutriment to the young plant until such time as it can avail itself of food provided in the soil. Sufficiently large seed is required to ensure these conditions without allowing the young plant to become stunted. It is for this reason that very small seed, such as chats, which pass through a mesh of $1\frac{1}{8}$-in. sieve, are not so valuable for seed—the shoot is naturally small, and the food supply is short, so if the preparation of the land is not good there is small probability of a successful crop. Seed larger than that which passes through a 2-in. sieve is wasteful, as it has a full market value, and much more has to be used to plant an acre.

While recommending, as being under ordinary circumstances the most profitable, that seed between the 2-in. and $1\frac{1}{2}$-in. sieve should be used, it is not intended to imply that larger or smaller seed should not be planted under other conditions. In experimental trials larger seed generally shows itself to be most productive, but if sound and of good quality it is wasteful to use them on a large scale, for they possess a very much greater selling value than that of smaller tubers, which, if not used for seed, must be sold as inferior ware, or be consumed by stock. Large tubers injured in digging or insect-attacked, are more profitably used as seed than food. Where land is well prepared those which pass through $1\frac{1}{2}$-in. sieves, but not through $1\frac{1}{4}$, are quite capable of producing a good crop. Where the land is badly worked such plants would produce an indifferent crop.

Knowing that the smaller sets are likely to produce, under moderate preparation, weaker plants, the remedy is closer planting. We have personal experience of as good crops being raised from chats, passing through $1\frac{1}{8}$-in. sieve and remaining on an inch mesh, as from good stout seed; but in such cases sets have been placed from 7 in. to 9 in. apart. When potatoes are very cheap there is no great saving in using small sets, but when dear, especially as in the case of newly introduced varieties, it is absurd to feed small tubers, as they are more profitably used as seed. Experience shows us that preparation of the soil is a larger factor in the production of good crops than is the size of the seed. At the same time, given the chance of large or small seed on the same terms, we should certainly use the stronger. A strong argument against using small seed is, that when potatoes run away from type they generally produce small tubers, and an excessive proportion of these are likely to be planted. The quantity of seed necessary to plant on the acre varies in accordance with the variety, and the type according to its time of maturing. Roughly from 12 to 15 cwt. of well-sized seed are required per acre. If very large seed is planted, more than a ton is necessary. Seven cwts. of small seed are quite sufficient to plant an acre, if the preparation is good.

M. Girard recently published a summary of his experiments on cut and uncut sets of various sizes, and the following table shows the proportions both of the yield of potatoes and of the percentage of failure to

produce plants in respect of each of the six methods of planting:—

Weight of Seed.	Percentage.	
	Weight of Crop.	Number of Failures.
Tubers of 3½ oz. planted whole - - -	100	6
,, ,, cut into two portions - -	69·36	12
,, 7 oz. ,, two ,, - -	82	10·5
,, 10½ oz. ,, three ,, - -	74	14·5
,, 1¾ oz. Two tubers planted together	95·36	3·7
,, 1 oz. Three ,, ,, ,, -	89·12	3·7

M. Girard points out that on comparing these mean figures with the particular figures relating to each variety, the difference between the former and the extreme figures is so slight that the mean may be regarded as conveying in this instance a very fair idea of the actual facts.

He thinks, therefore, that the experiments have shown that—

1. The maximum crop is obtained by planting entire tubers of medium weight.

2. The crop is diminished about 30 per cent. if such tubers are cut into two portions.

3. The crop is diminished, with rare exceptions, about 20 per cent. by planting cut seed, weighing 3½ ozs., from whole tubers weighing 7 ozs. or 10½ ozs.

4. If two or three small tubers, weighing in all 3½ ozs., are planted together, the crop is, on the

average, from 5 to 10 per cent. less than that obtained by planting whole tubers of medium weight.

The experiments warrant M. Girard's deductions, though we should not follow them entirely, as in growing nearly 200 acres annually we have to use a considerable quantity of cut sets, and our experience does not agree with that founded on these experiments. Occasionally on land in harsh condition in dry seasons cut sets have shown missed plants to some material extent, but in average seasons very few occur. Our experience concurs with his in his first note. In notes 2 and 3 our experience is not similar in degree. In the case of note 2, however, only half the seed was planted. To make the experiment level an equal weight should have been planted, which would have occasioned closer planting on the part of the cut sets. The practice of planting two or three small tubers in one hole, as mentioned in Note 4, does not give so good a result as planting them separately. We planted twenty acres of Wonder chats nine inches apart in the rows this year, in preference to planting small ones together, as our experience has shown it is more advantageous. The roots appear to ramify through the whole of the soil more rapidly than when two or more are planted in one spot. A very similar reason causes farmers to single their turnips and mangels, rather than leave them in bunches of two or three. But, as before stated, the preparation and condition of the soil have a great influence on the relative value of cut and uncut sets and of large and

small sets. Where farmers have sets under both these conditions they should, as far as possible, arrange that the cut and small sets should be placed where the conditions are most favourable for them to establish themselves, when it will be found that they will produce good crops, and that there will be few misses. Last season one cwt. of each of Farmer's Glory and Up to Date, cut so that there was but one eye in each set, yielded respectively 30 cwt. and 29 cwt. in open field culture, with only ordinary attention.

In our experience in experiments and general culture we have found that those which appear least injured by cutting include the Wonder, Up-to-Date, Farmer's Glory, Imperator, the Magnum Bonum, Bruce, Stourbridge Glory, Triumph, Reading Giant, Colossal, Thane of Fife, Her Majesty, Lady Fife, and Record. Those most affected by cutting are the Early Rose, White Elephant, Beauty of Hebron, Daniels, and others of that type, all varieties of Ashleaf, Early Fortune, and Jeannie Deans.

Cut Seed.

The question of cut seed is one which also has received attention for many years. Broadly speaking seed is not improved by being cut, though where the tubers are very large it is wasteful to plant them whole. Provided sufficient eyes are left, and there is sufficient substance surrounding them, there is not much difference in value of the cut and the uncut when planted under highly favourable conditions, but there is a gradual falling off in proportion as the pre-

paration of the seed bed deteriorates. On roughly prepared land in poor condition there is a wide difference between the value of cut and uncut sets. From an experience of many years on a vast number of varieties we find there is one broad rule in connection with cutting, and that is that the white blossoming varieties, which trace to the softer types of modern American introductions, are far more injured in the cutting than are the lavender flowering kinds, and we rarely hesitate to cut the lavender flowering sets if they are unduly large. It is important that when potatoes are cut they shall be planted within a very few days. If left in a heap they are liable to heat, which causes much injury to the young shoot. It is better, therefore, if from any cause the sets cannot be planted at once, that they should be sprinkled with quicklime, which cauterises the cut portion and prevents waste of sap. Seed dressed with lime in this way is less liable to insect attacks. Liming is, therefore, a useful practice at all times. It is highly important that cut seed be not left in large heaps, as it rapidly ferments. The chief injury arising from cutting is occasioned by fermentation, as the eyes are killed or weakened. Always spread cut tubers thinly about the floor of a barn if circumstances prevent their being planted immediately after cutting.

It is strange, considering that cut potatoes are less reliable for seed, that it is often recommended that a small piece should be cut from the heel end of the set.

This absurd practice prevails in many parts of Ireland. The reason for doing this is that the set may decay speedily. The practice doubtless originated from the idea that the decaying set was liable to cause disease in the plant, and the sooner it was destroyed the better. This idea has exploded. The origin of the blight is now known. The old set plays a useful part in attracting insects, such as julus worms, which frequently feed on that in preference to the young tubers, which they would otherwise infest.

Cutting Seed Potatoes.

It has been frequently shown in experiments that more robust plants, and plants which mature more quickly, are obtained from sets cut from the "rose" end of the potato. The rose end is that which contains the larger number of eyes, and is farthest from the place where the tuber was attached to the stem. The opposite end is known as the "heel." Casual observation shows that the eyes at the rose end are the first to commence growth, and while this is the case it is only likely that they will be the stronger in an uncut potato, as they get the first chance of the food contained in it; but when there is an equal amount of food in the divided portions there appears no reason why there should be any difference in the vigour of the shoots, but analyses have been made which show there is more starch in the rose end. In practice on a large scale the difference is not readily noticed. In gardens where the cultivation

is done at high pressure, and all endeavour is made to get the crop in as short a time as possible, the earlier shoots are worth the greater care; consequently it is advisable to use them, but when dealing with a large quantity of seed it would be absurd to waste the heel ends, as the gain from the use of the rose-end sets is not sufficient to counterbalance the loss thus sustained.

Effect of Cutting Seed Potatoes.

Great stress is laid on the quantity of eyes which should be left in the set; this, however, is a question which does not affect, to a great extent, the grower of considerable quantities, as it is impossible for him to find time to pick out the superabundant eyes. The grower of small quantities for exhibition, or for a particular purpose, may do this, and obtain better results. If a single eye is left in a potato the whole of the food goes to this one, and the young plant makes a vigorous start. The single plant thus raised occupies the ground allotted to it, and it has all the nutriment at its disposal. Under these circumstances the tubers formed grow to a considerable size, and fine exhibition tubers are obtained. Where a number of plants are grown on one spot the opposite result may be looked for. There are more tubers formed, but they do not grow to so great a size; however, the total weight is very similar.

Very choice seed may be cut small, as it may pay to get as many plants as possible. This is commonly practised on new seed. If the sets are planted under

very favourable circumstances, and great care is bestowed throughout the growth, one eye only may be left in each set. All that is absolutely necessary is that sufficient food shall be left to give the plant a start until it can establish itself in the soil. To cut down to a single eye where the land is poor or badly prepared is folly. Under ordinary circumstances two eyes at least should be left, as, if from frost, insect-attack, or injury, the only shoot is destroyed, the plant is dead, and the ground allotted to it is wasted. When very small sets are cut out they should be divided from the main set in such a way that each section is as nearly as possible of the same size. When cutting a set to form two sets it is usually advisable to divide it lengthwise, from rose to heel; but if the set is narrow it is best to cut it, dividing the rose from the heel end.

Change of Seed.

If seed of the same stock is sown on the same land, and under similar conditions, for a number of years, many of its valuable characteristics are lost, and the cultivation becomes unprofitable. The effect of not changing the soil is very similar to in-breeding with live-stock—the plant becomes enfeebled in every way, it is more susceptible to disease, it deteriorates in cooking properties, loses its yielding powers, and becomes untrue to type. It is therefore necessary to obtain seed grown on soil differing as widely as possible from that on which it is to be planted, and it is advantageous that it should have been grown in

another climate. Those holding large farms are able to change from one part of it to another, and this usually provides variation in soil, which is beneficial, but in course of time a change to a seed grown under more widely differing circumstances becomes desirable. Farmers living at a distance from each other may interchange seed, when the only extra expense incurred is that for carriage.

It is highly important that seed potatoes are not placed in bags which have contained substances injurious to the buds. Nothing is more injurious than sugar. A few years ago a large London dealer claimed a heavy sum, and obtained it after a full trial, against a foreign importer, who shipped a large order of seed potatoes in bags which had previously contained sugar, as they were useless for seed purposes. He was able to produce amplo evidence that sugar bags, when unwashed, would have this effect. Bags which have contained nitrate of soda, if unwashed, are very destructive to the buds. Those which have contained oil cake, or superphosphate of lime, may be used. These points must be borne in mind not only when the potatoes are sent long distances, but also when moving them from one part of the farm to another.

Effects of Flooding.

The buds are susceptible to injury from other causes. Immersion in water not only destroys the buds, but in a short time causes destruction of the whole tuber. The tuber is worthless if under water more than a

day. If a pit or clamp becomes submerged for that time the whole of the tubers decay. We have known instances where this has occurred. All care has been taken to place them under favourable conditions as soon as possible, but it has been useless. An instance recently came under our notice where a pit was submerged. As soon as possible they were taken into a large barn to dry, but within a fortnight, every one was rotten. In a few days they became soft, like a sleepy pear, and this was shortly followed by a putrid rot, so that they were carted away to the land as manure. In the same flood another pit was submerged. The owner, immediately he could get them out of the pit, sent them to London, but they rotted in the trucks, and were destroyed. Perhaps a more striking illustration of the injurious effect of water was shown in the case of a grower who dug a crop in a wet autumn which came out badly. The tubers were smothered with earth, which adhered to them; so the grower was somewhat alarmed for fear of their heating in the pit. To avoid this, he washed about half the crop, but had not time to treat the whole of them in this manner. They were stored under exactly similar circumstances, and when he opened the pit he found that the whole of those he had washed were putrid, while those he left smothered with earth were as sound as he could desire. We have seen the same result on newly-planted crops where a flood has stood on the land for a day.

Preserving Seed.

As the potato disease remains in a dormant condition in the tubers through winter, and assumes activity in summer, the importance of selecting, so far as possible, seed which is free from disease, is easily recognised. Badly attacked tubers are easily detected, but where there is a slight attack it is difficult to trace its presence. All reasonable precaution should be taken when selecting it, and an endeavour should be made to choose it from stocks which have not shown signs of disease when growing. Mr. Jensen recommended that the seed should be subjected to a temperature of from 100 deg. F. to 105 deg. F. for four or five hours, as by that means the hybernating mycelium was killed. The disinfection was to be carried out in an oven, so that they would be under the influence of dry heat. This recommendation was made several years ago, but has not come into practice, and is not likely to.

SECTION VI.

VARIETIES.

The importance of growing the best varieties cannot be too strongly urged. This is more patent every year. Potato culture is no longer a haphazard business. Public taste must be considered, and owing to the keen competition in all agricultural matters there is much more necessity to produce marketable samples. Potato growing on a large scale in England was restricted to a few districts until recent years. The restrictions imposed upon tenants rendered it impossible for them to embark in the cultivation of crops outside the few permitted in their leases; but times have altered, and now such restrictions are obsolete, thus rendering it possible for almost all farmers whose land is adapted for potato growing to engage in it. The monopoly has gone, and with it the high prices associated with it. One very striking feature connected with the extension of the crop has been the very careless manner in which those who have engaged in the work selected their seed. They intended to put in potatoes, and they put them in, utterly regardless of suitability. To them, anything that could be called a potato was sufficient for their purpose. As was natural, they were often supplied

with worn-out stocks, and potato growing did not prove profitable. It was fortunate for many that during the changing circumstances the Magnum Bonum was at the height of its vigour, and in good demand, for owing to its robust nature it struggled through deficiencies in the way of cultivation, and developed to a crop in spite of them. It might truly be said it proved the novice's friend in those days. But those days have passed. In a few specially favoured districts the soil seems to possess almost magical powers, and good quality is produced in spite of conditions which would prove disastrous on other soils, and climatic conditions admit of exceptionally early maturity; but it is highly important that the variety of potato to be grown should be recognised as being a matter for grave consideration.

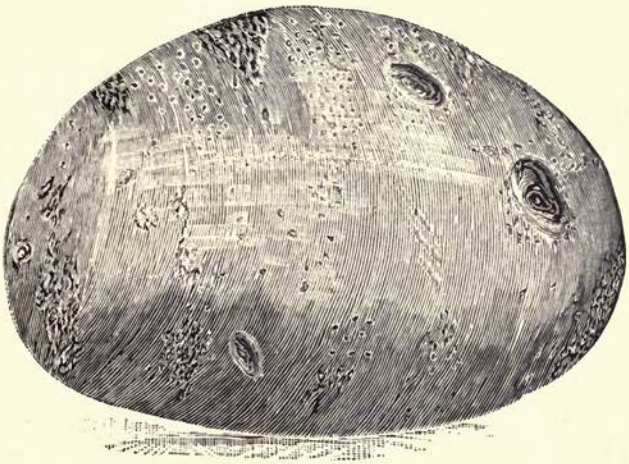
Valuable Points in Varieties.

The number of varieties now offered for sale is such that without close study and careful testing it is impossible to obtain a thorough intimacy with their characteristics. Appearance is as deceptive in a potato as in other things. A shapely, well-grown tuber, which makes a grand show in a potato exhibition, may be comparatively worthless, as its cooking properties may be inferior, or the stock from which it came may be exceedingly liable to disease. Perhaps it may be suitable for garden culture, where it receives exceptional attention, but may prove utterly worthless for field culture, where less care is bestowed. It may be from a

worn-out stock, or it may be a selection from an old stock, exhibited under the guise of a new name. It may be a new variety which has been produced from parent stocks which possess inherent weaknesses, though these may not be at present apparent in the new variety, but if it is kept in cultivation for a very few years they will develop, and cause it to be thrown into the limbo where so many other varieties have gone before it.

Home Experiments on New Varieties.

A personal experience is the only safe guide as to the value of a variety. Hearsay, especially if the information is from good authorities, is valuable, but it cannot always be relied upon. Moreover, a variety which thrives in some districts may prove a failure in others. While so many potatoes are grown as there are at the present time the greatest chance of profit is obtained from new varieties which are coming into repute. In other words, the time to hold them is when the stock is small and the demand is strong and increasing. Specially good prices are not obtained when they are in a large number of hands. It is, of course, impossible for ordinary growers to grow a large number of varieties on a large scale, but it is in the power of most to make tests with small quantities yearly. If this is done, and those which appear specially valuable are followed up, the real value of the sort will be proved in subsequent trials. We can speak emphatically of the advantage of these home



"THE WONDER."

LATE FLATTISH ROUND. WHITE.

Grown by Messrs. Malden Bros.

trials, as they have proved of great value to ourselves. It was by means of these trials that we were able to discover the value of the Wonder, at a time when there were not half-a-dozen growers of it in the country, so that we were able to get up a big stock by the time its reputation was made—sudden though that was. The Market Favourite, as an early variety, proved its qualities under the same conditions. The Up-to-Date and other varieties revealed their good properties similarly. In contrast to these many have proved they were valueless, notwithstanding the high recommendations with which they were launched. In greater contrast still, varieties of which we purchased heavily on the strength of the high eulogies with which they were introduced, proved the folly of not testing them previously. The tests should be made early in the career of the variety, as afterwards the potato runs on its own merits.

Enumeration of Valuable Points in a Variety.

The principal points to hold in view when selecting a potato are its good cooking qualities, its power of resisting disease, its yielding properties, its colour (both of the skin and the inside), the nature of the skin itself, its shape, the depth and frequency of the eyes, the period at which it matures, the size of haulm, its vigour, trueness to type, and tendency to make second growth.

Cooking Properties.

The cooking properties can be ascertained only by

cooking. There are more or less reliable indications of quality when uncooked, and these were, to a great extent, relied upon by purchasers of large quantities in the markets until within the last few years; but since consumers have become more exacting on the point, it is usual to cook a sample from bulk as being the most satisfactory guide. The market method is to take a sample from the railway truck, and either steam it or boil it, a little stove being kept at hand for the purpose. A strip of skin about half-an-inch in width, and extending right round the potato, is taken off. No other preparation is made. When cooked, the potato should be free from any appearance of wetness; it should be throughout in a dry floury condition, which, on slight pressure, should break to pieces or be readily reduced to a coarse meal free from hard lumps; in colour it should be white, the particles glistening as though they were crystalline. It is not sufficient that these characteristics are obtainable immediately after cooking, the highest price is not given unless it keeps white when cold. Many potatoes when freshly cooked appear white, but gradually assume a darker colour, and these do not rank as first quality.

Potatoes which are of a dark yellow when cooked, or show any colouration whatever, are not so saleable as those which are white and remain so, no matter how good the flavour may be. Those which cook to a black colour and are wet and clammy in consistency rank as bad. In plentiful seasons these are almost

unsaleable, except to meet a very low-class trade, or as food for farm stock. The flavour should be mild, and free from earthiness. Many otherwise good potatoes are spoiled by a tendency to develop tubers, which split in the centre during growth, leaving a hollow space; when this occurs a hard, dark-coloured core forms. It was for this reason that the Champion so soon went out of cultivation in England. In Ireland, where the practice of cooking potatoes with their skins on them, and serving them in that condition, commonly prevails, this objection had little weight with consumers, as they cut off the sound part and left the core, and this potato is still largely cultivated. Where potatoes are mashed, or cooked under other circumstances which prevent the convenient discarding of objectionable portions, these hollow cores are a decided disadvantage. It is, perhaps, only fair to potatoes to state that they are very frequently cooked in a careless manner, with little regard to their peculiarities, many of which could be overcome if due attention and skill were bestowed on the cooking. A potato which cooks to a mealy condition is a very digestible food, as with proper mastication the whole of the starch contained in it is thoroughly acted upon by the saliva, but a tough potato is a severe tax on all but the most vigorous digestions. This one point alone is of sufficient value to make it worth the consumer's while to pay the difference charged for potatoes of good quality beyond that charged for those of inferior quality.

Power of Resisting Disease.

The power of resisting disease is a highly important one. To some extent it has been rendered less important during the last few years, since the introduction of spraying with the Bouillie Bordelaise. This useful check to the disease has rendered it possible to grow varieties which, without it, prove unprofitable; but still, disease-resisting properties must be considered one of the most valuable characteristics of a variety. Circumstances are sometimes such that spraying cannot be thoroughly done; or disease may appear so suddenly and spread so rapidly, that the whole acreage cannot be gone over. It is therefore a great gain to possess a variety which, in years when disease is rampant, will thrive and come to maturity without the trouble and expense of spraying.

Yielding Properties.

The yielding properties of a variety are of highest importance, especially as the highest prices realised for potatoes rule low in comparison to those made in bygone years. The expenses of cultivation vary very little, whether the crop is a light or heavy one. A few shillings an acre extra for digging a heavy crop is all the difference that can be looked for. A rather smaller yield may be condoned in the very early varieties, as it is expected that prices will rule high when they are dug, and beyond this, a catch crop may be taken after them, so that the return from the land will altogether amount to a large total during the

year; but late varieties must possess good cropping capabilities to prove profitable.

Colour.

The colour of the skin, whether of a red shade or a light yellowish brown, is a point which varies in importance. As a rule, coloured potatoes are not in high favour, though occasionally they are most sought after. At the present time a red potato is very difficult to sell, but the very slight blush of pink on the Beauty of Hebron does not interfere with its sale. The pink and red potatoes are usually associated with the more tender American varieties, which possess good quality and fairly early maturing properties, but a too ready susceptibility to disease. It is more difficult to detect disease in a coloured potato than in a plain one, particularly in the early stages of the disease.

The Skin.

The nature of the skin is a point for consideration. Too much stress should not be laid on it, as it is not an absolute guide. As a rule a skin of moderate thickness, which appears slightly flaked so as to form a network, is a good indication of quality. Perhaps the most wonderful network ever seen on a potato was that carried by the Village Schoolmaster, which was very pretty and of a handsome dark russet colour. The quality of this potato was excellent, but it was too susceptible to disease to take an important place in cultivation, especially as it was so delicate that the

most careful treatment was necessary for its success. When well treated it possessed good yielding properties. The skin should be clear except for the network, not too thick nor too thin. A liability to scab or blotchiness is prejudicial to it. Splitting is very objectionable, as wherever this occurs a portion of the potato is deteriorated.

A potato which on cooking appears white and snow-like is always preferred to one which becomes yellow. A few varieties of potatoes, such as the Nigger and Congo, possess a deep crimson colour throughout, but these are used for decorative rather than culinary purposes. A dye is also extracted from them.

Depth and Frequency of Eyes.

The depth and frequency of the eyes are points for consideration. Deep eyes to some extent indicate robustness, frequently coarseness. The buds are well protected from injury by blows, and they usually sprout well. In wet land they tend to hold moisture, and as the bud is very susceptible to disease they provide conditions favourable to its development. Deep eyes are strongly objected to where the custom of peeling potatoes previously to cooking obtains, as such a large portion is wasted in cutting them out. Lightly regarded in Ireland, they are considered highly objectionable throughout Great Britain. Some varieties develop a great number of these, and are proportionately less valuable. In potatoes of the Regent and Champion types the eyes are deep, inclined to be

round and proportionately of small diameter; those of the Magnum Bonum and Snowdrop types flat and shallow, very difficult to perceive at times until the bud sprouts. The American Early and Second Early types, such as the Puritan, White Elephant, and Beauty of Hebron, are distinguished by somewhat shallow eyes, semi-circular above the bud but nearly straight below.

The Haulm.

The size of the haulm should be observed, as it has a bearing on the cultivation. First Early varieties, and the earlier Second Earlies should not be too gross in the top, as they act as a check to greens or cabbages when planted in them. Late varieties may be longer, but there is no advantage in it except on foul ground, where they are required to smother weeds. Very large tops are difficult to spray thoroughly, and this is an important consideration. Varieties with strong, hardy haulm, suffer less from spring frosts. The time at which the variety matures must, of course, be taken into consideration; in selecting it the nature of the soil and climate, and the particular market or trade it is required to meet, have to be borne in mind.

Vigour.

The vigour possessed by a variety is of importance, because on that depends very much the power of overcoming difficulties at different periods of growth. Varieties possessing little vigour find difficulty in establishing themselves during the early part of the

growth; in fact, they are often shy budders. Frost affects them readily, and they possess small recuperative powers after it. Vigour is usually associated with strong disease-resisting properties, but not always.

Fixity of Type.

Some varieties are liable to lose their distinctive features. The type is not sufficiently fixed. This is perhaps most common in those varieties which are hybrids of red stocks. When this is shown it is usually found that the variations are inferior to the variety when first introduced; the tubers are smaller, and show a tendency to "kindle" or produce a large number of very small chats.

Second Growth.

Second growth, after-growth, super-tuberation, or growing-on are terms used to denote that the growth has not been uniform throughout. Some varieties are especially liable to this detrimental feature. It is most common among kidney varieties, especially when from various causes the seed becomes deficient in vigour. The kidney potatoes show it in the form of a dumb-bell, variously spoken of as "lady-waisted," "waspy," "dollies," etc. The round varieties more often show it in the form of warty excrescences, which may be broken off, though not always. Some very vigorous varieties, such as the Imperator, when first introduced, throw out from a newly-formed tuber a cord of varying length, which is similar in all respects to the stem carry-

ing the first formed tuber. This cord shoots from the opposite end to that which bears the first tuber, and is, in fact, a narrow continuation of it.

Second growth is caused by a temporary check in the formation of the tuber, but some varieties are much more liable to it than are others. When potatoes are grown on the same soil and under the same conditions for a number of years the potato loses vigour, and very slight causes are sufficient to effect a check in the formation. When conditions become more favourable the formation continues, but instead of the tuber thickening in the part already formed it grows on at the end. The tendency to develop second growth increases as the time from the introduction of the variety increases, and often leads to its being discarded. If a quantity of potatoes show great variation in type, and a large number have acquired second growth, it is probable that the stock is a bad and weak one. However, if the season in which they were grown was a dry one, it is possible that other influences may have unduly affected them. If a long drought causes the plants to stop growing for a time after the tubers have commenced to grow, and is followed by copious rain, after-growth may be expected, even in the case of vigorous varieties. With this exception an ill-shaped sample should be regarded suspiciously.

Modern Varieties.

Great attention has been paid during recent years to the development of new varieties, consequently the

list of those which possess many points of merit is a very long one. Of course there are some varieties which stand out more prominently than others, and it may fairly be taken that those varieties which come into highest repute do so on their merits, although there are instances where potatoes possessing highly valuable properties fail to attract the attention they deserve, because their colour or shape is not in accordance with the popular taste at the time of their introduction.

Some varieties which are excellent in all their points at the time of their introduction deteriorate with such rapidity that in the course of three or four years they are no longer profitable to cultivate. Others, especially those which are too vigorous and coarse when brought out, tone down and improve in quality. An attempt to mention all the varieties at present in cultivation will not be made here; they can be found in seedsmen's lists; but those which are worthy of particular notice will be given. Potatoes vary so much in important characteristics that it is not easy to make a classification which readily shows all the divisions that are desirable for the assistance of the potato grower.

Division of Varieties by the Ripening Period.

The chief division is that of—

Earlies.
Second Earlies, or Mid-Season.
Late, or Main Crops.

The Earlies are those which come first into the market, and are suitable for forcing. Unless required

for seed purposes they are dug green. The Second Earlies are those varieties not fit to dig quite so early as the Earlies, but which are suitable for digging green to meet the summer market. Among them are many very heavy-cropping varieties, and they can, therefore, be left to mature before digging. All early varieties have a more or less marked tendency to disease.

The Late varieties are those which do not come to maturity until autumn; the later kinds often continue to grow until cut down by frost.

Division by Shape.

Another division is that of shape, the sections being

Round.
Kidney.
Oval.

The Rounds are more liable to go hollow inside, but their shape allows them to be worked to a more even size on the sieves, as the narrow kidneys often work through the meshes endwise. They therefore make more marketable samples. The preference for a round or kidney shape is very ephemeral, though rounds have been in greatest favour in Ireland for a number of years. Round potatoes are generally most popular with restaurant caterers.

Kidney potatoes include many popular varieties. One of their worst features is their aptitude to second growth in times of drought, when they lose their kidney shape and become hour-glass shaped; the

second growth cannot be separated from the first growth, and, as the two ends rarely cook evenly, the quality is greatly impaired. Round potatoes produce protuberances which can be easily knocked off, and the quality is less injured.

Oval potatoes are somewhat long, resembling kidneys, but they are thicker through the cross section at the middle, and taper towards both ends, whereas the rose end of the kidney is thicker than the heel end, and the kidney varieties show a greater tendency to second growth.

Division by Colour.

Another division is that of colour of the skin, which is composed of

White, including those with yellow or brownish strains.

Coloured, including all shades of red or pink.

The colour of the flesh, whether white or yellow, may be taken as a section, but the dividing line is very indefinite, as the shades merge into one another, and the matter is so much one of comparison that the division cannot be definitely made. Some varieties, however, are so essentially white, and others so yellow, that a distinction may well be made between them.

Varieties are sometimes spoken of as disease-resisting. This, however, is only a comparative term, as, though the power of resisting disease is much stronger in some varieties than in others, no variety is absolutely proof from disease; though for a few years,

while possessing their full vigour, some newly-introduced varieties do not suffer materially.

The colour of the flower is a distinction which chiefly affects the value of the Second Earlies, or other varieties which are crosses with them, as the varieties which have what is known as the recent American strains in them are white-blossomed. White-blossomed varieties, although often of choicest quality, are frequently spoken of as soft varieties, and the seed potatoes suffer very much if cut too small.

List of Popular Varieties.

The following is a list of potatoes which have attained a recognised place in general culture, and from this may be assumed to have possessed exceptional merit. In some instances they have passed beyond the zenith of their fame, but find favour in special districts. They are given indiscriminately as to popularity and merit.

			Colour of Bloom.
Kidney or Oval.—			
	EARLIES.		
Ashleaf (including many selections), specially early			White.
Sharpe's Victor, specially early			,,
Early Puritan			,,
Duke of Albany			,,
Monarch			,,
Early White Beauty			,,
White Beauty of Hebron			,,
Thorburn	Rather deeper eyed comparatively.		Coloured.
Beauty of Hebron			,,
Early Rose			,,
American Rose			,,
Snowdrop			White.
Snowflake			,,
Cole's Favourite			,,

EARLIES—*continued.*

	Colour of Bloom.
Round.—	
Early Regent	White.
Early Market Favourite	,,

SECOND EARLIES.

Kidney or Oval.—		
White Elephant ...	Comparatively deeper eyed.	... Coloured.
The Daniels		... White.
Empire State		... ,,
Supreme		... ,,
Early Fortune... ...		... ,,
Jeannie Deans		... ,,
Early Beauty		... ,,
Reading Russet		... Coloured.
International Kidney		... White.
Round.—		
Abundance		... White.
Kemp		... ,,
Perfection		... ,,
Windsor Castle		... ,,
Lady Fife		... ,,
Lady Frances...		... ,,
Her Majesty		... ,,
Red Bog		... ,,
Adirondack		... Coloured.
Beauty of Bute		... White.
Village Blacksmith		Dark Brown.

LATE.

Kidney or Oval.—	
Stourbridge Glory	White.
Bruce	,,
Magnum Bonum	,,
Drone	,,
Future Fame	,,
Record	,,
Maincrop	,,
Farmer's Glory	,,
Colossal	,,
Reading Giant	,,
Satisfaction	,,
Up-to-Date	,,
Farmer	,,
Colonel...	,,
Antrim	

LATE—*continued.*

Round.—	Colour of Bloom.
The Wonder	White.
Imperator	,,
Thane of Fife	,,
Champion	,,
Schoolmaster	,,
Garton	,,
Reading Hero...	,,
Sutton's Seedling	,,
Best of All	,,
Sirius	,,

Remarks on Early Varieties.

The following remarks on some of the foregoing varieties are based on a personal experience in the field and in the market, and they are proffered as such.

Earlies.

The Ashleaf is a very distinct variety, and possesses more than any other the peculiar flavour associated with new potatoes, and is esteemed accordingly. Many selections of this variety are in the market. It is not a heavy cropper, but owing to its earliness and suitability for forcing, is often highly remunerative. It is essential that it is planted in well prepared land and carefully nurtured. It is therefore more generally regarded as a garden than as a field variety. Sharpe's Victor has won for itself a good position, because although nearly as early, it is a heavier cropper than the Ashleaf.

The Early Regent has gained great popularity as an early variety, and is extensively grown, being well suited to forcing.

The Early Market Favourite is a comparatively new variety. In our private trials during the past three years it has consistently proved itself the heaviest cropper of the earliest varieties. It crops very heavily, and is perfect in quality. Its early and heavy cropping powers render it suitable for forcing or for maturing. It is equally suitable for the garden and the field. The Early Puritan, Duke of Albany, Monarch, and Early White Beauty, represent a type of Early slightly later than the foregoing. They possess good quality and good cooking properties. The Thorburn and Beauty of Hebron are very similar. The Beauty of Hebron is of such good repute that it is representative of best quality on the London markets in summer time. High-class ware, even that which is not coloured, is often sold as Beauty of Hebron. It has been on the market for several years. It hardly ranks as an early First Early, and in later districts is looked upon as a late Early, or early Late variety. The Early Rose, the American Rose, and many other closely allied species, have had a long run. The quality is often variable—in some seasons excellent, and in others difficult to sell. They have proved valuable in the production of new varieties of Earlies and Second Earlies. Cole's Favourite is the best of the Snowdrop type. It is the heaviest cropper we have experience of as an Early. It is excellent when dug green, and equally good if allowed to mature. On our soils it is the most profitable Early in open field culture.

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SUTTON'S WINDSOR CASTLE.

SECOND EARLY ROUNDISH WHITE.

Introduced by Messrs. Sutton and Sons.

Second Earlies.

The White Elephant is a strong sport from the same stock as the Beauty of Hebron. Although very coarse, and in wet seasons proved a poor cooker when first brought out, it has toned down so much that it is now very similar to the Beauty of Hebron. It is still rather the heavier cropper.

The Daniels was rather inclined to coarseness when first introduced, but like White Elephant, toned down. The growth is very similar. It is now always of excellent quality,

Jeannie Deans is a newer variety, which has speedily achieved fame for its good cooking and yielding powers.

The Reading Russet is a very handsome potato, and is valuable for show purposes. The International Kidney is also very popular.

The Abundance is a particularly handsome, good-cropping variety, which cooks well. In some seasons it has a tendency to go hollow at the centre, but is, nevertheless, a very valuable potato.

The Kemp is very popular in Ireland. It is a full cropper, but is more suitable to the Irish than the English markets.

The Beauty of Bute has recently attained popularity around Dublin, and is a useful variety, suitable for English markets. It crops well.

The Windsor Castle has already, in a short time, come into high favour. It is a good all-round variety, with nothing that we know of to detract from its merits.

Lady Fife, Lady Francis, and Her Majesty are three very valuable varieties, raised by Mr. Findlay. They are well established, although but recently brought out, and may be regarded as being of exceptional value. Suitable for the garden or for field culture.

The Adirondack is one of the most handsome coloured potatoes in cultivation, and is rarely absent from show collections.

The Village Blacksmith is essentially a garden variety. It is of choicest quality, but is not sufficiently robust for field culture. Its beautifully netted skin gives it an unique appearance.

Late Varieties.

Late Kidneys.

The Magnum Bonum has been regarded as the typical Late Kidney during the past nearly twenty years, and it now supplies the name for most of the potatoes of the type sold in the markets. It retained its vigour longer than any variety of recent years. Where carefully selected it is still valuable, though from careless selection and want of proper change of soil it has deteriorated in many instances. Its chief fault is that of second growth. As a disease-resister it has stood out pre-eminently above all other varieties, which have taken a prominent place for a long period, during the past twenty years. Many valuable new varieties have been obtained from crossings with it.

The Stourbridge Glory is the best potato of this type which we have grown on a large scale during the past few years.

The Bruce runs the Stourbridge Glory a close race, and is preferred by some growers.

The Reading Giant ranks among the best Late Kidneys, and is often dug green. It is suitable for almost all classes of soil. It is a good all-round variety.

The Colossal is a comparatively new introduction, which has attracted much attention on account of its great cropping powers. The tubers are large, but well-shaped, and, considering their great size, very uniform. It is fast coming into notoriety.

The Main Crop has been popular during the past few years. In seme places this year it has shown a tendency to "kindle"; in others it has done well.

The Sirius is notable on account of the high place it has attained in the Warminster trials. It heads the list in point of yield. It is said to be of excellent quality, and resists disease in a marked manner.

The Up-to-Date has been out long enough for its high merits to be appreciated, although it is a comparatively new variety. Last year we grew thirty cwt. from one cwt. of closely-cut seed, which was at the rate of fourteen tons per acre, in open field cultivation. There was no trace of disease, the quality was perfect, the skin beautifully netted, the flesh white, and not a coarse tuber in the crop. We intend to grow it largely in the future.

The Farmer's Glory falls short of the Up-to-Date in one respect only—it is hardly so perfect in shape. We grew fifteen tons per acre in field trials last year.

The Farmer and the Colonel are two varieties grown in Ireland. They crop heavily, but the quality is not of the best. The Antrim has become rather more popular. It may improve on further cultivation.

Late Rounds.

The Wonder is, in our opinion, the best Late Round in cultivation. We have grown it three years, and in each year it has surpassed any of the more than sixty varieties against which it has been pitted. Similar reports are given from the other districts in which it has been grown. With cut seed, in unfavourable seasons for planting, we have grown from 12 to 13 tons per acre each year. Its cooking properties are superior to anything we know. It is a splendid disease-resister, of good shape, shallow eyes, and is suitable for field or garden culture. It is a cross between the Magnum Bonum and the Imperator. The tubers are exceptionally handsome, and notwithstanding its vigour and heavy cropping powers, none of them are coarse, but are of good marketable size.

The Thane of Fife is an excellent Scotch potato, which is now becoming popular in the South. When well supplied with manure it is an exceptionally heavy cropper. Seems to thrive best on soils with good substance. Is very strong in the haulm. It cooks very well.

The Imperator is one of the heaviest croppers in cultivation. Its exceptional vigour when first brought out rendered it somewhat unpopular, but it soon toned down and became one of the most remunerative varieties. The tubers, when first brought out, frequently weighed 2 or 3 lbs. Its quality was spoken of on the markets last season as being superior to that of any previous season.

The Reading Hero has had a long career, during which it has been held in high esteem. It is remarkable for the even size of the tubers, which are all of marketable size.

Sutton's Seedling is a popular variety, which is reliable for quality and yield. From its first introduction it has been held in high esteem.

The Garton is a Late Second Early, or Late variety, of comparatively recent introduction. Though not well on the market yet, it has been sufficiently grown to prove its merits. It is likely to come into more general cultivation.

The Champion, Ireland's greatest blessing for several years, but now, owing to its proneness to disease, somewhat the reverse, shared some years ago with the Magnum Bonum the highest esteem of growers. Its aptitude to go hollow at the centre destroyed its popularity among English growers, though it is still grown in Scotland. In Ireland it represented the greater part of the potato crop for many years; in fact, it probably does so still. For many years it was the only variety which found favour in Ireland (where

kidney potatoes never attain popularity), on account of its being able to withstand disease. This characteristic has now left it, and for a late variety it is exceptionally liable to disease. It will be a good day for Ireland when the farmers put it aside for a safer variety.

The Schoolmaster is one of the best potatoes for eating late in the spring. It is rather too shy a yielder for field culture, but it retains its cooking properties after all other varieties have deteriorated.

Trials with Thirty-six Notable Varieties.

Below is an epitome of a trial carried out by us on thirty-six varieties to ascertain their relative values and distinctive features. The trial was made in 1893, which was a specially hot season, and not a favourable one for Early varieties. The notes were made in the field, and are given as taken at the time. The crops received no special treatment, and were grown in the open field. The varieties are of good repute, and the list is a valuable one of those worthy of a place in field culture, though they are equally suitable for the garden.

1. Early Ashleaf.
2. Myatt's Ashleaf.
3. Early Regent.
4. Sharpe's Victor.
5. Duke of Albany.
6. Beauty of Hebron.
7. Snowdrop.
8. Snowflake.
9. Triumph.
10. Supreme.
11. Perfection.
12. Windsor Castle.
13. Abundance.
14. Satisfaction.
15. Early Market Favourite.
16. Her Majesty.
17. Lady Francis.
18. Lady Fife.
19. Thane of Fife.
20. Jeannie Deans.

21. Early Fortune.
22. Early Beauty.
23. Bruce.
24. Magnum Bonum.
25. Stourbridge Glory.
26. French Violet.
27. Blacksmith.
28. Colossal.
29. Reading Giant.
30. White Elephant.
31. The Daniels.
32. Schoolmaster.
33. Union White.
34. Imperator.
35. The Wonder.
36. Sutton's Seedling.

At the end of June, end of July, and on other occasions, the following notes were made :—

No.	End of June.	End of July.	Date of digging.	Total weig't
				lbs.
1	Small top, erect growth, lavender flower ...	Small top, ripening ...	Sept. 6	28
2	Medium top, erect growth, lavender flower	,, ,, ...	,,	46
3	Small spreading top ...	,, ,, ...	,,	40
4	Small spreading top, rather larger than 3...	,, ,, ...	,,	28
5	Medium small top ..	,, ,, ...	,,	32
6	,, ,,	,, ,, ...	,,	52
7	,, white flower	Medium top, no flower ..	Oct. 2	70
8	,, ,, rather smaller	Small top, no flower ...	,,	50
9	Tall, light-coloured top, weakly, but improving	Medium large top, no flower	,,	76
10	Medium small top ...	Medium small top, no flower	,,	60
11	Large top, white flower	Large top, white flower	,,	84
12	Medium top	Medium top, white flower	,,	72
13	Large top	Large top, white flower	Oct. 26	94
14	Medium large top, dark green, lavender flower	Large top, pale lavender flower	Oct. 2	82
15	Medium spreading top	Medium top, dark green, no flower	Sept. 6	78
16	Large top	Large top, reddish lavender flower	Oct. 10	147
17	,, ...	,, ,, ...	,,	115
18	,, ...	,, ,, ...	,,	115
19	Compact dark green, medium large top	Large top, dark green, whitish lavender flower	,,	120
20	Large top	Medium large top, dark green, no flower ...	Oct. 2	118

No.	End of June.	End of July.	Date of digging.	Total weig't
				lbs.
21	Large top, white flower	Large top, white flower, lighter foliage than 20	Oct. 16	119
22	Large top	Large dark green top, no flower	Oct. 2	114
23	,, very similar	Large top, lavender flower	Oct. 26	105
24	,, ,,	,, ,, ,,	,,	85
25	,, ,,	,, ,, ,,	,,	108
26	Curly leaf, dark stem, medium top	Large medium top, curly leaf, lavender flower ...	,,	80
27	,, ,,	Medium top, no flower, curly leaf	Oct. 2	65
28	Large top	Large stiff top, no flower	Nov. 2	116
29	,, ...	Large top, lavender flower	,,	122
30	Medium large top, white flower.	Medium large top, much white flower	Oct. 16	90
31	,, ,, ...	,, ,, ...	,,	98
32	,, lighter-coloured leaf	Medium top, no flower	Oct. 26	80
33	Large top, lavender flower	Large top, much lavender flower	Nov. 2	115
34	Very similar	Very similar	,,	117
35	Medium large top, dark green leaf	Dark foliage, medium top, few white flowers	Oct. 26	104
36	Medium small top, light green	Small medium top, no flowers	Oct. 2	94

The following general notes were also taken:—At the end of July the six first varieties were showing signs of ripening, the haulm turning yellow, Sharpe's Victor being most advanced. All the other varieties were in full vigour. At this stage no difference was perceptible between the Imperator and Union White; between the Daniels and White Elephant; between the Duke of Albany and Beauty of Hebron; between Her Majesty, Lady Francis, and Lady Fife; between Bruce, Magnum Bonum, and Stourbridge Glory.

Of the Scotch varieties, the Early Beauty and Jeannie Deans ripened earliest, the Early Fortune last; the other five varieties very much together, the two first mentioned being ripe in the third week of September, five varieties October 10th, and Early Fortune October 20th.

Sutton's Triumph, Windsor Castle, Perfection, and Supreme ripened in the third week of September. Supreme rather the earliest, Perfection the latest, though Supreme was about the same time.

On the 15th October, the varieties showing the greatest amount of vigour in the haulm were the Colossal, Union White, and Imperator; then the Wonder, French Violet, Reading Giant, and Early Fortune. The only other varieties showing any life were the Stourbridge Glory, Magnum Bonum, and Bruce. The Wonder, Imperator, and Union White were a somewhat gappy plant, owing to the seed being cut too small.

Trials with Scotch Varieties in England.

The following trials, with recently introduced Scotch varieties, carried out by ourselves, may be of interest as being conducted in England in two years widely differing in respect to moisture and temperature. They formed part of tests made with a large number of varieties on our own farms, and were grown in open field. In both seasons the weather in the spring months was very dry, and in a few cases cut sets died. We estimated that the loss occasioned by dead

sets amounted in the case of Early Fortune to 20 lbs. in 1892, and 40 lbs. in 1893, and in 1892 Jeannie Deans lost 20 lbs. The quantity of seed planted was in each case 7 lbs.

Variety.	1892. lbs.	1893. lbs.	Total 2 years. lbs.
Thane of Fife	168	120	288
Her Majesty	119	147	266
Bruce	112	105	217
Early Beauty	98	114	212
Early Fortune.....	78+20	119+40	197+60
Lady Fife	78	115	193
Jeannie Deans.....	70+20	118	188+20
Lady Francis	70	115	185

Newest Varieties.

There are many new varieties in the hands of the leading seed firms which are likely to achieve notoriety; in fact, in limited quantities they have already gone far to establish their reputations, but at present it can hardly be said that they are in general cultivation. Under these circumstances they are purposely not alluded to here individually. Descriptions of them can be obtained in the catalogues of the firms introducing them.

SECTION VII.

TREATMENT DURING GROWTH.

The Flat System.

When potatoes are planted on the flat after-cultivation should be commenced early. If the ground is firm from any cause whatever, ordinary harrows or the grubber should be worked as soon as the rows show sufficiently to act as a guide across the field. The tines should be worked to as great a depth as the land has been previously stirred. If this is commenced early the tines may be set so as to be worked very close to the sets; in fact, it is often desirable to work so closely that the broad flanges run underneath the sets to lighten the ground immediately under them. The advantage of having the crop put in in straight rows is now plainly seen; those sets which are not in the rows are displaced if an attempt is made to move the land as closely to the rows as is desirable. Grubbing should be done in the early stages of the crop's growth, otherwise the rootlets are broken. The common practice of using tines with the flange set at right angles to a straight stem, so as to form an L, is wrong; the flanges should be fixed on to a curved stem thus , as the hoe draws into the ground of its own accord, and the stem need not be run so closely

to the plants. This holds good in all horse-hoeing and grubbing work. No work is more valuable than the thorough stirring and lightening of the soil during the early stages of the crop's growth.

The hand-hoe should be set to work as soon as circumstances permit. This is particularly necessary with such varieties as those which form tubers early in their growth. This affects all Early varieties, such as Ashleaf, Hebrons, Puritans, Sharpe's Victor, and many others, as if weeds once make a strong growth the crop suffers. The necessity of guarding against a check in the growth of any early variety cannot be too strongly urged. The period of growth is short, and any hindrance causes a loss of yield and quality. Weeds must be kept in check, and the proper time to effect this is when they are young and tender.

Moulding-up.

Moulding-up must be done in good time. In gardens it is usual to mould-up on more than one occasion. A slight moulding is given when the plants are about six inches high, and the final moulding is done as soon as the plants are large enough for a full-sized ridge, in accordance with the space from row to row, to be formed. The hoe is most commonly used for this. An ordinary swan-necked hoe with a ten-inch blade is as serviceable as anything, though occasionally the triangular hoe is used.

In field cultivation the moulding is generally performed at one operation. The double-breasted

plough, or a special moulding-up implement, is used. In wet seasons it is often very difficult to get the moulding-up performed at the proper time, as it is important that the land shall be in a dry condition, otherwise the earth is plastered down firmly about the stems, and if dry weather follows it sets hard, and the formation of the tubers is interfered with. If the operation is delayed too long, some of the roots are destroyed, and those tubers which are forming near the outside of the ridge, become exposed when they

MOULDING-UP PLOUGH. FIG. III.

increase in size, causing them to become green and of less value. As a rule, early varieties need not be so thoroughly moulded as is required for the main crop varieties, but the thoroughness of the moulding has a great effect on the degree of disease which affects the tubers. Deep moulding undoubtedly prevents, to some extent, the loss occasioned by disease. The formation of the ridge is somewhat regulated by the soil and climate. In districts where the rainfall is usually light, especially where the soil is of a very open nature, it is important that the rain should be conducted to the ridge, so that the plants may fully benefit by it.

The top of the ridge should therefore be somewhat flat. On heavy land and in wet climates the ridge should be formed narrow at the top, so that the water may be conducted to the furrow. When growing potatoes on a large breadth, the three-row moulder is found useful, because of the expedition with which the work is accomplished. A stout steerage horse-hoe frame, which carries hoes or mould boards, as occasion requires, is a most useful implement, as almost all the horse labour required by the crop can be effected by it. From three to four acres can be moulded up with an ordinary double-breasted plough in a day, but from ten to twelve may be ridged by a three-row moulder. It is, of course, important to mould up thoroughly, because if not, many of the tubers turn green by exposure and are spoiled for culinary purposes. Some varieties shove out of the ground more than others. After moulding is effected there is no opportunity to hoe the ground, and the further cleaning is restricted to the pulling out of stout annual weeds.

The Ridge System.

The treatment of the crop where the potatoes are planted on the ridge, or, as it is sometimes termed, in drills, differs slightly, as there is less chance to use the horse-hoe. The saddleback harrows are very useful to clear the ridges, and lighten them before the crop appears above ground. Small weeds, which would otherwise prove injurious to the crop, are thus killed before they can do damage, and the cost of doing it is

very light. After the crop appears above ground cleaners of the type of the Era hoe and grubber can be used with advantage, as the outer blades can be set so as to lightly pare the ridges and destroy the weeds Horse-hoeing, as carried out on the flat, cannot be effected so readily, especially where farmyard dung has been laid in the ridges. Hand-hoeing can be done with much advantage on weedy land. When the crop is cleaned, and the tops have reached sufficient height, the earth should again be moulded up to the ridges.

The Lazybed System.

On the Lazybed system the crop should be kept clean by hoeing, and fresh earth should be dug out of the trenches and laid about the plants so as to cover in the young tubers. The spraying with a solution of sulphate of copper and lime should be given once or more during the growth of the crop; but this matter will be dealt with fully in the chapter devoted to diseases of the crop.

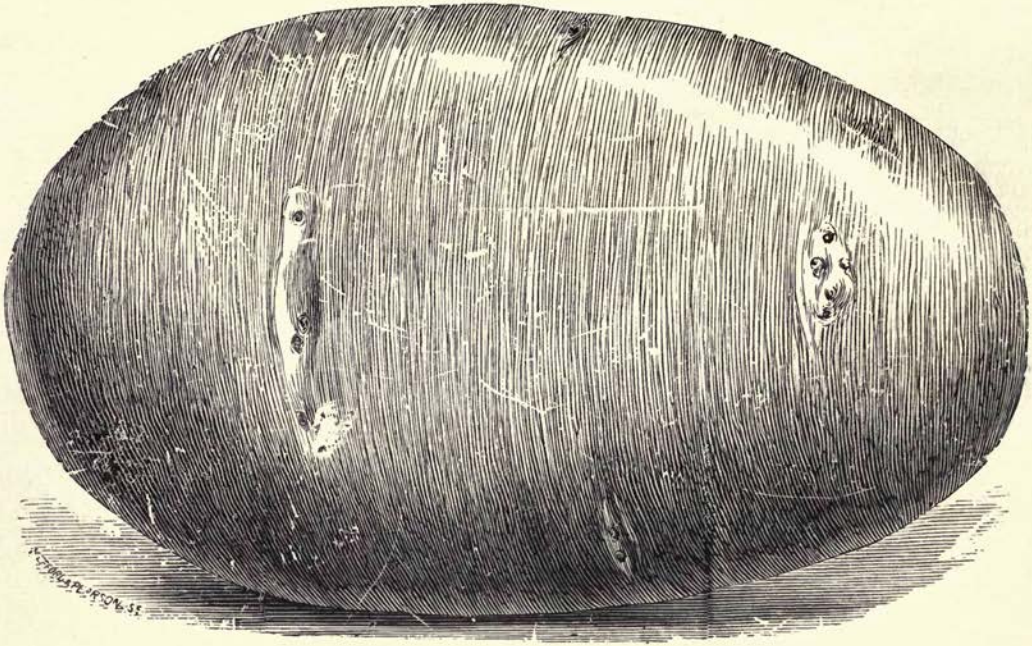
Destruction of Fruits or Apples.

It has been recommended that the fruits or apples should be prevented from forming, as the energies of the plant are directed towards their formation at the expense of the tubers. As, under natural circumstances, the first object of the plant is directed towards the production of seed to ensure its reproduction, this appears reasonable enough, but it is rarely attempted in practice, and in those instances where it is done,

little good appears to be accomplished. The production of seed does not appear to have sufficient effect on the growth of the plant to render it worth troubling about.

Scaring Rooks.

Rooks are often very troublesome at the time of planting and when the tubers are forming. They are very suspicious of danger, and there is, perhaps, no better method of keeping them from the crop than by stringing the field. Very fine twine is best for the purpose, and this should be carried on sticks three or four feet in height. It is best kept tightly strained. It is sometimes necessary to shoot a few rooks. Scarecrows are not much use after they have been set up a few days.



CARTER'S GOLDFINDER.

LATE KIDNEY. WHITE.

Introduced by Messrs. Carter and Co.

SECTION VIII.

DISEASES OF THE CROP.

The potato is liable to several forms of disease, chiefly brought about by fungal agencies. It is also subject to attacks of insects, some of which cause great injury. One disease, however, stands out pre-eminently as causing the greatest loss to the grower, and this is commonly spoken of as *the* potato disease. This disease first caused serious loss in England in 1845, and for nearly half a century it ran its own course unimpeded; but fortunately a check, if not an entire preventive, has been brought into use in the form of a spraying of sulphate of copper and lime in solution applied to the leaves. For this, growers are indebted to M. A. Girard, a Frenchman, who was acquainted with the beneficial effect of the solution in checking fungal attacks on the vine, and who recognised the possibility of its proving equally serviceable in checking the potato disease. After carefully testing its effect, he made known its value in this direction, and it has been proved on all sides to hold the disease in check sufficiently to warrant its general adoption.

The Potato Disease.

The potato disease is caused by a fungus (*Phytophthora infestans*, until recently commonly called *Peron-*

ospora infestans), which attacks the potato plant whilst growing, and, having established itself in it, spreads to all parts of the plant, setting up decay wherever it goes. The tubers are not exempt, and when it reaches them putrefactive decay is set up, which often causes them to rot at once, and at any rate spoils those portions of them which it reaches so that they are unfit for culinary purposes.

Appearance of the Disease.

The appearance of the disease when a crop is attacked is unfortunately too well known to require much description; the leaves turn brown, and later on a strong putrid odour is recognisable even at a distance. If a plant is examined in the early stages of the disease small brown spots are noticeable about the leaf and stem, and unless these are carefully observed there is nothing to show that they are not dying in the ordinary course of nature. Closer inspection, however, reveals the presence of a greyish line of mould just where the green and brown portions of the leaf unite, especially on the under side of the leaf. This edging is in reality a streak of mould very similar, to the naked eye, to the mould which is noticeable on decaying vegetables, cheese, old boots, and other familiar substances. The mould has a powdery appearance, but if it is looked at under a magnifying glass it will be seen that it is composed of an immense number of fine threads which occasionally branch, and that they carry small ovoid fruits called conidia. These branches,

called aerial hyphæ, spring from threads or roots of the fungus within the leaf, and are called, collectively, mycelium, also known as submerged hyphæ. The fungus lives within the plant, feeds on its juices, ultimately breaking up its structure, causing the plant

Fig. 14—A potato-leaf, showing the spots and patches of "potato-disease," due to the ravages of *Phytophthora infestans*. In the darker patches the tissues are quite dead: the margins of the spots would show the hyphæ of the fungus, standing off much as in Fig. 15. *After Sorauer.*

to die. It is a parasite of the potato, much in the same way that the mistletoe is a parasite of the oak or apple-tree.

Perhaps the parts of the fungus can be best understood if they are compared with the parts of a plant of wheat. First, the roots of the fungus running within

the plant may be likened to the roots of the wheat running within the soil; the roots fix the plant and absorb the necessary food. Then the fine stems or threads of the fungus which appear outside may be compared with the stems of the wheat, and the seed cases of the fungus, containing the little seeds, may be compared with the ears of the wheat containing the kernels or seeds of wheat. In the same way that the wheat takes the plant food from the soil, so the fungus absorbs the juices of the potato plant; but it does more—it sets up decay.

The Growth of the Disease within the Plant.

The manner in which the mycelium pervades the leaf is shown in Fig. 15. The small section of leaf, highly magnified, is shown with lower side uppermost. The aerial hyphæ most commonly find their way out of the leaf on the under side, as this is supplied with almost innumerable small openings, or breathing pores, called stomata, which admit air, from which carbonic acid is extracted, to assist in building up the plant. These openings afford easy egress to the hyphæ, particularly as the threads of mycelium are able to form more readily near to the under side, as the upper section is largely occupied by structural cells, which, from their resemblance to palings, are called palisade cells. The intermediate cells in which the mycelium is most plentifully found are the living cells—that is, the cells are those which are actively engaged in assimilating the food taken into the plant

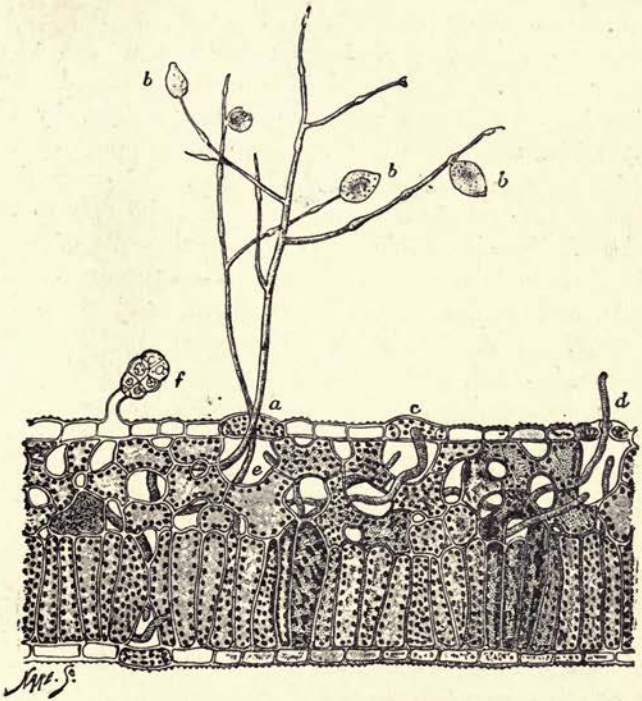


Fig. 15—Section of potato-leaf in the tissues of which is the mycelium of *Phytophthora*. The hyphæ run between the cells, and send through the stomata (*a*, *c*, *d*) the aërial branches which bear the conidia, *b*. *f*, one of the peculiar hairs of the underside of the leaf. The dark parts of the tissue of the leaf show where cells are dying from the effects of the parasite. Highly magnified. The normally upper surface of the leaf is here turned downwards. *Marshall Ward.*

through the roots and leaves, converting it into substances ready to form new parts of the plant. These cells are placed irregularly, and not close together, as the air is required to circulate round them. The juices of these cells are readily seized by the mycelium, and instead of going to the support of the plant, they go to maintain the fungus. The mycelium spreads throughout the plant, and finds its way to the tubers. Here it travels between the cell walls, expands the intercellular space, absorbs the contents of the cells, and finally breaks them down, and the tuber decays. Fig. 20 is an illustration by Professor Marshall Ward, showing the mycelium attacking the tuber, by running through the intercellular spaces, and absorbing the contents of the cells. Figs. 24, 25, 26 are other illustrations of the disease in tubers, by Mr. Beaven. As the leaves are destroyed, the plant can obtain no air internally, consequently no food is assimilated, and the plant speedily dies.

Perpetuation of the Disease.

The manner in which the disease is perpetuated and kept alive from one season to another, does not appear to be satisfactorily agreed upon; at any rate, different methods are suggested. The manner in which the disease is conveyed from plant to plant, however, is satisfactorily determined. Mr. Worthington Smith demonstrated some years ago that the disease was carried on from year to year by means of resting spores or ripened seeds, produced intersexually within

the tuber and other parts of the diseased plant; also that these could retain vitality independently of the potato when once they had matured, all that was necessary to bring them into activity being suitable temperature and sufficient moisture. These spores, on germinating, broke up into several spores, which were easily transported by the wind, and if they fell upon a potato plant when conditions were favourable to their germination they immediately attacked it and set up disease, the further development being regulated by climatic influences.

M. de Bary, however, demonstrates that there are no resting spores to carry on the disease, but that the mycelium within the tuber becomes dormant during winter, but returns to activity in spring, when conditions are suitable. This view is very largely accepted. It is, however, unfortunate that Mr. Smith's view cannot be refuted on other grounds than that others who have made investigations have been unable to detect what he asserts he has seen. It may be absolutely true that the resting spores do not exist, under which circumstances they could not be seen; but those opposed to his view can only go so far as to say they cannot detect them. On the other hand, some of the *Phytophthoræ*, the most closely allied sub-division of fungi to the *Phytophthora infestans*, differing, even in their microscopic size, only in the most minute degree, are known to produce intersexual resting spores, which carry on the disease from year to year. With this knowledge it appears reasonable that their close re-

lation, the *infestans*, should possess a similar faculty. Under all circumstances we can only get to the point that one clique says they exist, while another negatives it. This is a very unsatisfactory condition of affairs for the cultivator of potatoes. M. de Bary says the disease is only carried through winter in the tubers, therefore it is only necessary to destroy all tubers affected by it and the disease becomes extinct, except for the small quantity which is found on other solanaceous plants, which is admitted to be very small. According to M. de Bary's view it would be needless to burn the haulm of diseased potatoes, and it may safely be used to manure land to produce a crop of potatoes in the following year. Mr. Smith says that all haulm—in fact, all parts of the diseased plant—should be burned. And no one can definitely prove which is right. M. de Bary may be right in saying no resting spores are developed now, but it would be difficult to prove that they were not formed at the time Mr. Smith asserted he detected them. They may not have been formed or present, but having in view the fact that closely allied plants do produce them, it is not outside the bounds of possibility that they may be developed at any future time. Concensus of opinion in one direction induces one to think that M. de Bary's must be the correct view, for the greater number of those who have made investigations follow him; but even majorities have been wrong. Who is to settle the matter? Meanwhile, is the farmer to follow the popular verdict, and use his haulm for litter and manure, in which it

possesses no inconsiderable value, when the large acreage of the crop grown is taken into consideration, or is he to burn it and lose this value? If he follows the dictates of the majority of scientific investigators he will be foolish enough to risk the chance of their being right, and will not destroy the haulm, but use it. If he distrusts them he will be foolish enough to burn the haulm and lose the value it possesses. While the matter is in its present state it is correct to follow M. de Bary in believing that the disease is only propagated by means of the dormant mycelium, but it is safer to distrust it so far as to destroy the haulm. According to M. de Bary, the mycelium assumes activity when the temperature is favourable, and ramifies through the plant as it grows. If circumstances are favourable the mycelium bursts through the leaves and the aerial hyphæ bearing the spore cases are produced. Mr. Smith says that the leaves are struck from the outside, and when the spores germinate they find their way into the plant and ramify to all parts.

The Spread of Disease.

The manner in which the disease is carried from plant to plant is fortunately proved satisfactorily. The conidia, or spores, are carried on the aerial hyphæ or branches of the fungus growing outside the leaf. The branches are jointed somewhat like a bamboo cane, and a conidium is given off at each joint. These contain a thick liquid substance which, when the conidia ripen and are placed in moisture, breaks up

into several smaller spores, called zoospores, so extremely minute that when 3,000 are laid side by side in a line they only reach an inch.

The zoospores soon emerge from the spore, and each one of these becomes quickly furnished with two

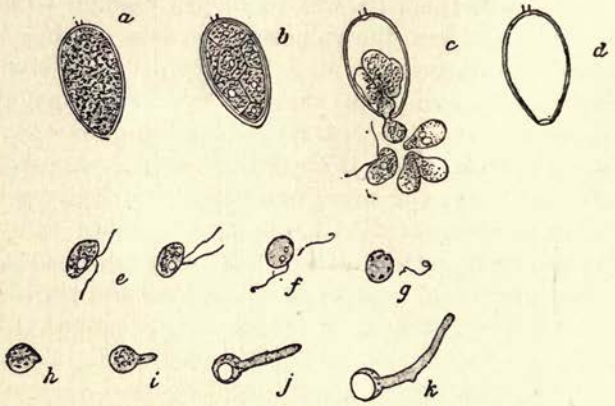


Fig. 17—The stages of germination of one of the conidia of *Phytophthora*. (*a*) the ripe conidium in water; (*b*) protoplasmic contents breaking up into blocks, which separate and escape (*c* and *d*) as minute kidney-shaped zoospores (*e*), each with two cilia; *f* and *g*, the zoospore coming to rest and losing its cilia; *h*, *i*, *j* and *k*, successive stages of germination of the zoospore. Highly magnified. *Marshall Ward.*

extremely fine hair-like cilia, tails or vibrating hairs. The zoospores are able to move in the slightest film of moisture, being propelled by the whipping motion of the cilia. After a brief time the little zoospores, or animal-like spores, rest, and take a globular form, and the vibrating hairs dissolve away, or drop into the

finest dust. After a brief rest the zoospores burst, and produce a thread of spawn. This thread is capable of carrying on the existence of the potato fungus. These tiny zoospores are easily transported on the air, or by birds, insects, or other agency, and if they alight on a potato plant, thrust their thread of spawn into the leaf, and establish themselves in the plant. As bearing on the prevention of the disease by means of spraying with the Bouillie Bordelaise, or sulphate of copper and lime solution, the marvellous instinct these zoospores possess of recognising when they have found a suitable host on which to establish themselves, is worthy of notice. If the germinating zoospore produces its thread of spawn on any substance but part of a potato, tomato, or other solanaceous plant, the thread does not attempt to pierce it, and the zoospore shortly dies. But if it falls on a potato plant—more readily if on the leaf—the thread of spawn at once endeavours to force its way into the plant; and this is rendered more easy because the tip of the thread is furnished with a substance which is of the nature of ferment, possessing the power of dissolving its way through the outside of the leaf. It is by rendering the surface of the leaf obnoxious to the little thread of spawn, by covering the leaf with a thin film of copper, that the disease does not enter plants which have been sprayed with the Bouillie Bordelaise. The stem is liable to attack, as the zoospore can pierce through the skin and find its way to the cells. Deep moulding-up of potatoes prevents, to some extent, the disease attack-

ing growing tubers. This is accounted for by the zoospore dying before it comes in contact with the tuber. A zoospore may germinate on the surface of the ground, but as it does not live many minutes,

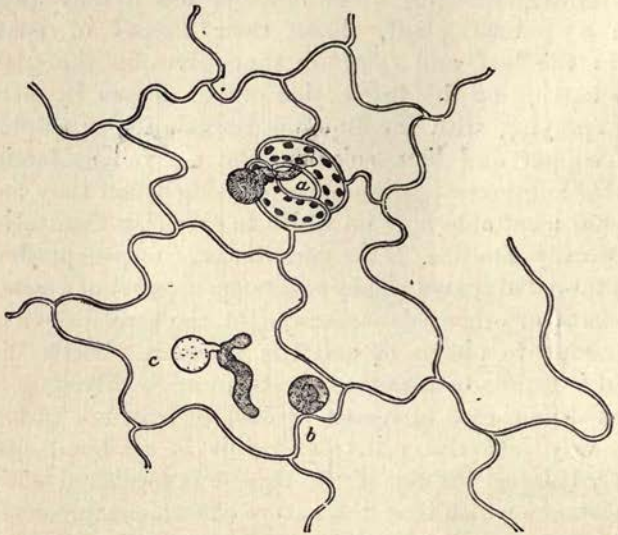


Fig. 18—Germination of zoospores of *Phytophthora* on epidermis of potato. At *a* the germ-tube is entering a stoma; at *c* it bores directly through the cell-wall. Very highly magnified. *Marshall Ward.*

before it is washed down to the tuber it may be dead.

When the zoospore has worked its way through the outer tissue of the leaf it comes into contact with the living cells, from which it at once commences to extract food, and it rapidly grows and spreads about

the plant in the manner previously described. The living cells are all-important to the plant, as in them the whole of the substance of the plant is manufactured; and as, in a badly attacked plant, all the matter which would go towards the building up of the tubers is arrested, this would be sufficient to render the crop unprofitable, but as decay is set up also, the plant withers and dies. In mild attacks, when the weather is cool,

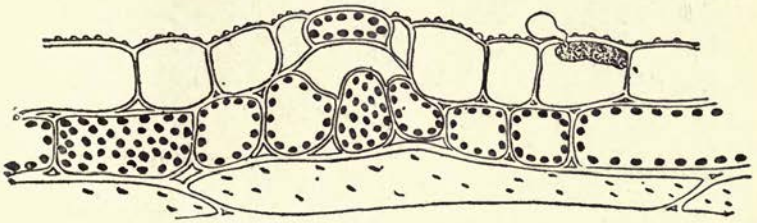


Fig. 19—Longitudinal section of potato-stalk, with germinating zoospore, the germ-tube of which has pierced the cell-wall, and is growing inside the cell. Very highly magnified. *Marshall Ward.*

or in varieties which, from their special vigour, are able to combat with the disease, the total destruction of the plant is not effected, and sometimes the disease does not spread to the tubers, but the yield is lessened by the absorption of the newly-formed starch.

The threads of fungus spread through the plant, and in warm, moist weather, increase with rapidity, and shortly break through the leaf, usually on the under side, because of the greater number of stomata, which form convenient outlets for them. These aerial hyphæ develop rapidly, and on these the conidia, or spores,

soon form. The formation of these spores is very much dependent on climatic influences, and in cold, dry

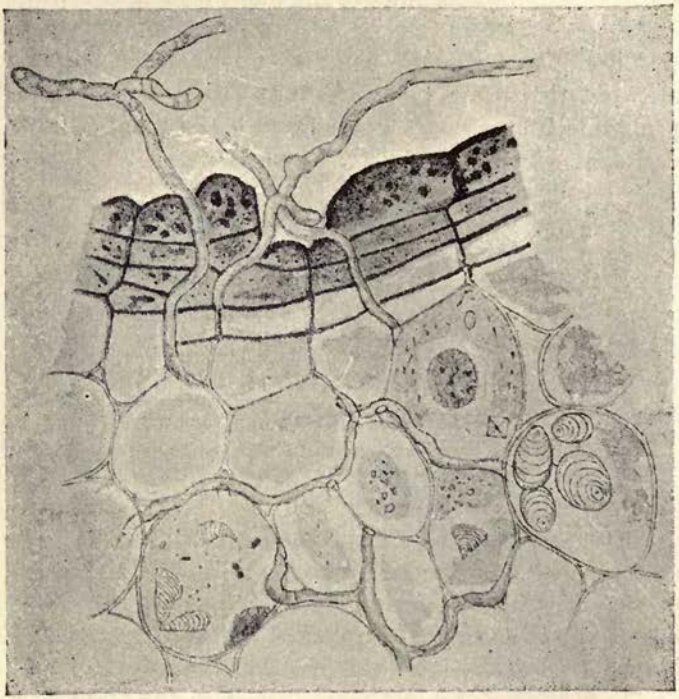


FIG. 20. SECTION OF DISEASED TUBER, SHOWING MYCELIUM TRAVERSING CELLS, AND ABSORBING CONTENTS. *Marshall Ward.*

weather very few are formed. The mild, moist weather of thundery seasons supplies the most favourable con-

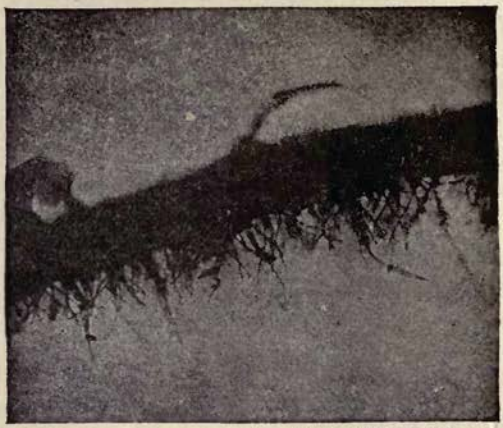
ditions for their growth, and it is usually found that crops rapidly show signs of disease, which becomes more virulent as this kind of weather continues. It is found that the temperature most favourable to the development of the disease is 73 deg. Fahr.; above 78 deg. Fahr. no germination takes place; below 50 deg. Fahr. there is practically no germination.

As soon as the conidia form they are blown away, and in favourable seasons the air about a potato field is charged with incalculable millions of these spores, all of which are capable of setting up a fresh attack of disease. It is, therefore, not surprising that the disease spreads rapidly, for in a fortnight each of the spores which establishes itself is able to give off millions of spores. The disease must have been established in the plant for several days before it becomes visible to the naked eye. As each of the spores is capable of giving off so many spores, it is obviously important that the plant should be rendered as impervious as possible to attack in the first instance, and it is because of this that the early spraying of potato crops is so necessary.

Where so many of the spores are given off it is only natural that many fall or are washed down upon the soil, and this accounts for a large number of the very frequent instances of diseased tubers on plants which have not been struck in the leaf. It is noticeable that those varieties on which the tubers form in clusters about the stem are more often attacked than are those which form singly at a distance from it. This is

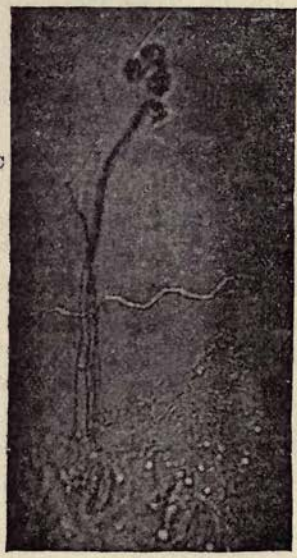
SIX MICRO-PHOTOGRAPHS TAKEN IN CONNECTION WITH THE WARMINSTER EXPERIMENTS.

A



A.—*Pytophthora infestans.* SECTION OF LEAF OF POTATO WITH EXTERNAL ORGANS OF *P. I.* x. 20. Most of the conidia have fallen off. It is very difficult to cut and mount sections of leaf without their doing so, but the illustration shows the relative size of the external hyphæ compared with the thickness of the leaf and with the leaf hairs. The hyphæ, it will be seen, are considerably shorter than the leaf hairs. Fig. 21.

C



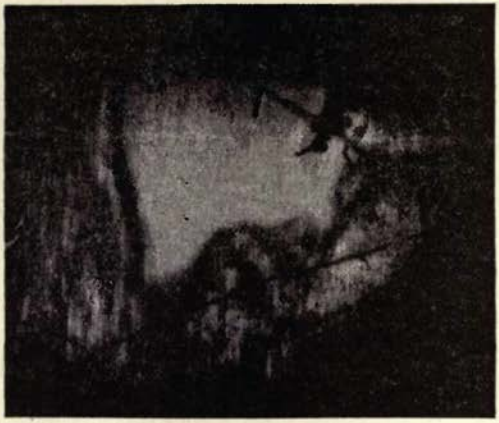
C.—*Phytophthora infestans.* x. 100. HYPHA EMERGING FROM STOMATA OF LEAF OF POTATO PLANT. The conidia are out of focus. The second filament, on the right, has the appearance of mycelium, the protoplasmic matter of which is more granular than that of the hyphæ. This specimen was obtained, after many attempts, by detaching a minute portion of the under-skin of the leaf with the hypha *in situ.* Fig. 22.

B

B.—*Phytophthora infestans.* HYPHÆ WITH CONIDIA. X. 100. (Zeiss Apochromatic Objective and Projection Ocular.) The upper portion of the hyphæ only is shown. Fig. 23.

F

F.—*Phytophthora infestans.* MYCELIUM IN CELLS OF TUBER. X. 200. (Zeiss Apochromatic Objective and Projection Ocular.) The illustration shows two angles of one cell, the cell-walls being scarcely traceable; also probably the direction of another cell-wall overlying the first. The mycelium travels between the cell-walls, expanding the intercellular spaces, and finally breaking them down. The cell contents were previously dissolved out. Fig. 24.



E

D

D. and E.—*Phytophthora infestans.* MYCELIUM CROSSING CAVITY OF DISEASED TUBER. X. 20. The small protuberances shown upon the mycelium in E, it has been suggested, may possibly be immature oogonia and antheridia. Figs. 25 and 26.

accounted for, because the spores which rest on the leaves are washed down the stem by rain, and vast numbers of them enter the soil at the base of the plant. If a potato plant is noticed it will be seen that the stalks and stems are grooved in such a way that a very large portion of the water which falls on them is conducted to the centre of the plant. This provision of Nature's to carry all the water to the roots is, of course, highly beneficial in dry climates, but is prejudicial where the disease has become so general.

Moulding-up to check Disease.

The value of deep moulding is easily understood when it is remembered that the zoospore lives but a few minutes. Protective moulding was one of the chief means adopted for preventing disease before spraying was introduced, and it would be wrong to discard it now. It is because moulding should be thorough that the rows of potatoes should not be placed too near to each other, as, when close, sufficient loose earth cannot be obtained to make the ridges.

The recommendation that the haulm of the potato should be bent down so as to lie in the furrows between the ridges has its value, as the spores are largely carried down into them by rain, and are not so easily blown away. The rain, instead of carrying the spores down the stem, washes them directly into the furrow, where they are harmless. A disadvantage is that the haulm does not dry so quickly after rain, consequently the disease is more likely to continue developing.

The matter of getting a free circulation about the plants is a very important one, as it is highly necessary to keep the plants dry. If the plants are absolutely free from outside moisture, disease cannot establish itself in them, consequently the greater freedom from wet conduces to keep them healthy. This points to the necessity of keeping the land free from weeds, as when there is a mass of them about the plants there is little chance for them to dry; in fact, no matter how fine the weather, the weeds about the bottoms of the stems almost always contain moisture.

After-Disease.

The fact that tubers are easily struck with disease must not be forgotten at the time the crop is dug. If the disease is still rampant in the top so that conidia are being given off, the freshly dug tubers are very liable to be attacked; in fact, to this and to the mycelium already in them, is due the "after-rot," which takes place in the clamp or pit after they are stored. For this reason potatoes are best dug in fine drying weather, so that the moisture, which is necessary for the development of the disease, may be quickly evaporated; and it indicates that fermentation in the pit should be avoided as much as possible, as the heat and moisture thus generated afford favourable conditions for the establishment of the disease.

Destroying Haulm to check Disease.

It has been recommended that the haulm should be

cut off of crops stricken by disease. This is a practice which can rarely effect much good. The leaves are the manufactory of the plant on which all developments are dependent. If these are destroyed the tubers must cease to grow, and as by far the larger amount of growth of tubers takes place during the few weeks the plants are dying down, little good can be done by destroying them when growing. There is some reason in doing it if the crop has approached maturity, and the tubers have reached a fair size. The cutting down of the haulm has sometimes been done with advantage late in the autumn, not with the view of checking disease, but to kill the crop, so that the skin of the tubers may harden sufficiently to permit of their being dug before severe frost sets in and destroys them. This, of course, can only be done profitably when the tubers are well developed.

Dressing with Bouillie Bordelaise to prevent Disease.

Spraying with Bouillie Bordelaise (or the Bordeaux Mixture), or a solution of sulphate of copper and lime, applied to the leaves of potato plants to check the disease known as *Phytophthora infestans*, is one of the most striking practices introduced to agriculture during the past few years. The possibility of holding the disease in check by any such means, or by any treatment of the growing plant, was looked upon ten years ago as an impossibility, and though the fact that it is now possible is firmly established, there are still

many growers who, not having tried it, retain their prejudice, and cannot grasp the belief in its efficiency. The numerous experimental trials, and the more extended tests in ordinary farm practice, have, however, firmly established its value, and its general adoption is now merely a matter of time. The cost of the spraying will prevent its use to some extent, as the operation may be regarded as an insurance against loss by disease, and there are those who always prefer to risk loss than lay out a sum to protect themselves, hoping that their good fortune may carry them through without their suffering too severely. Experience, however, shows that in this instance the insurance is a wise precaution.

Spraying does not secure perfect immunity from disease, but if commenced in good time it enables the plant to withstand attack so that, even in years when disease is exceptionally rife, it is little checked by it. If spraying is done carefully, so that all parts of the haulm and leaves are covered with a film of the solution, the fungus will not attack them, but as new foliage is formed, or the spray is washed off, re-spraying may be necessary. The attack on the tubers by the spores washed on to them, is not affected by the spraying. The attack through the hybernating mycelium in the seed cannot be prevented, but it is probably lessened in its severity.

Experiments with Bouillie Bordelaise.

A large number of carefully conducted experiments

have been made in England, Ireland, France, and other countries, and these show conclusively how great the efficacy of the spraying is. We personally conducted a series of experiments in Ireland in the years 1893 and 1894. These experiments were carried out by thirty farmers in various parts of the country. An epitome of the results for the year 1893 is given below:—

Variety.	Icreased yield due to Spraying.	Value at £2 per ton.	Profit per statute acre after deducting 14s. for Spraying.
	ton. cwts.	£ s. d.	£ s. d.
Champion	1 6	2 12 0	1 18 0
The Bruce	1 11	3 2 0	2 8 0
Farmer	1 2	2 4 0	1 10 0
Colonel	1 11	3 2 0	2 8 0
Antrim	1 4	2 8 0	1 14 0
Duke of Albany ...	1 5	2 10 0	1 16 0
Snowdrop	0 17	1 14 0	1 0 0
Abundance	1 1	2 2 0	1 8 0
Empire State ...	1 7	2 14 0	2 0 0
Satisfaction... ...	0 18	1 16 0	1 2 0

The striking feature in these results is that they were obtained in the driest season on record in the country, and one in which the disease was very light; in fact, it was commonly stated that there was no disease in the country. Very few tubers rotted in any part of the country, and even on the duplicate plots, alongside those which were sprayed, there were rarely any diseased tubers. The haulm, however, was generally affected, though it was not commonly realised that the yield of tubers was lessened by it. The whole of the results were collected. and the

average struck, which showed that there was an average gain per acre of from one pound to forty-eight shillings, according to the variety, after deducting fourteen shillings per acre allowed for two dressings, although in some cases only one was given. The increase was due to the potatoes being kept alive and in a growing condition after the unsprayed had withered.

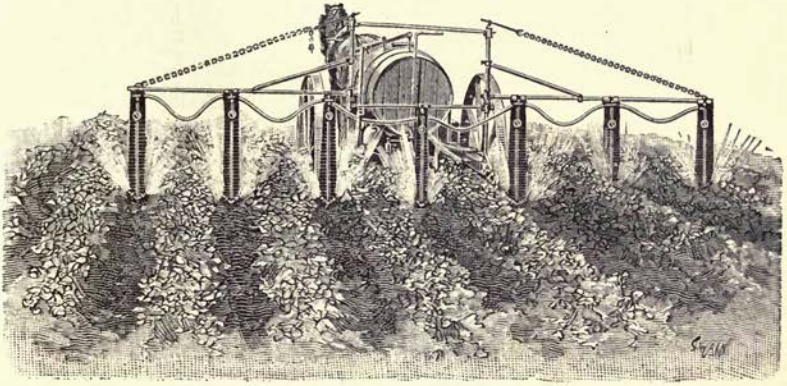
The Royal Agricultural Society of England carried out a series of experiments during two seasons, and, as our farms were chosen as one of the trial grounds, we are able to speak with confidence as to the results. In all cases the plants continued to grow after those unsprayed were dead, and the yield was correspondingly increased, and the numbers of diseased tubers were lessened. The Warminster experiments carried out for the Wilts County Council, which, as they are so well organised, and embrace so many features of interest to growers, must always hold a specially high place in the estimation of all interested in the crop, have confirmed other trials, and have shown the value of spraying.

During the past three years we have used the spray on the greater part of the 200 acres of potatoes we grow yearly, with such satisfactory results that it will continue to be part of our ordinary farm practice.

Constituents of Bouillie Bordelaise.

The Bouillie Bordelaise was the solution first recommended, and it has been generally adopted. This is

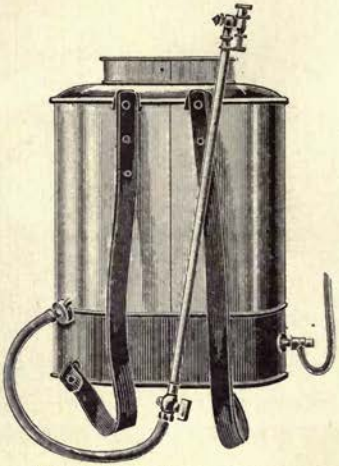
the mixture introduced by M. Girard, who commenced experiments in 1888 with the view of checking the disease, but it was not until 1889 that the remedy was made known in England. The first systematic trials were made in England in 1890. The mixture consists of 20 lbs. of sulphate of copper, 10 lbs. of quicklime, in solution with 100 gallons of water, this



7-ROW STRAWSON'S HORSE SPRAYER.

being the quantity usually recommended to spray an acre of medium top potatoes; but the quantity must be increased for larger crops. It was urged that the introduction of molasses would help to make the dressing adhere to the leaves, but it has not proved of sufficient value to warrant its adoption. The sulphate of copper is directly responsible for rendering the leaf unsuitable as a host for the fungus. The lime

neutralises the caustic properties of the copper, and helps it to adhere to the leaves. The water forms with them a solution which renders their distribution convenient. The object desired is to distribute this solution in such a manner that all parts of the haulm and leaf will be reached. To effect this special



STRAWSON'S HAND SPRAYER.

machines have been brought out. Messrs. Strawson's rank highest, as in the trials carried out under the auspices of the R.A.S.E., at Cambridge, in 1894, they obtained the medal and prize for manual, and the same honours for horse-power machines. M. Vermorel's "Eclaire" knapsack sprayer, very similar to Strawson's "Antipest," is also a good hand-power distributor.

Hand Spraying Machines.

The hand sprayer is suitable for use in gardens and in places where a small breadth of potatoes is grown, but where a large acreage is planted the horse-power machine is more suitable, and can be worked more profitably. With a hand machine, a man can spray from one to two acres per day, according to the size of the crops and the quantity of the solution to be applied, if the solution is prepared for him. With a horse machine taking seven drills at once, upwards of twenty acres may be dressed in a day. A great advantage of the horse machine is that a large acreage may be rendered secure against the disease in a very short time, and as the outbreaks of disease are very sudden in their appearance, and they spread throughout a field with almost incredible rapidity, the importance of being able to spray a large quantity in a short time is readily understood; especially as the dressing prevents, rather than cures the disease. To render the crop safe, the dressing should be applied before the disease is noticeable, or before the weather is such as to render it probable that a serious attack may be expected. But while the weather keeps fine the disease appears to be a long way off; and, as the plants are growing, there is an inducement to postpone the work, because the longer it is delayed the necessity of dressing again is delayed also.

Preparations for Spraying.

In making preparations for spraying, it is important

to secure pure sulphate of copper, as in commerce it frequently contains impurities. Sulphate of copper is now worth £17 per ton in London. Sulphate of iron is a common adulterant, and may be detected when making the solution, because instead of the mixture assuming a blue hue, it turns brown. Ground sulphate of copper dissolves more readily than that in blocks. It is necessary that thoroughly fresh-burned lime of good quality be procured. If not, the caustic properties of the copper will not be neutralised, and there will be an undue amount of sediment, which will prove troublesome when working.

Requirements when Spraying.

Several vessels are required in the field. The water-cart to bring water to the field. A large tub or two if water has to be fetched a long distance. Three tubs, each sufficiently large to prepare as much of the solution as the barrel of the machine will hold. Thus, for a 60-gallon machine, 70-gallon tubs are required; and for a 40-gallon machine 45 to 50 gallons. In addition to these, several wooden buckets, marked so as to indicate the gallons, are required. All vessels used in mixing should be of wood, as the copper rapidly affects metals. It is convenient to have a boiler to heat water to dissolve the sulphate of copper, though this is not absolutely necessary if the work is proceeded with systematically, or if the solution of copper is made previously. When the latter is done the specific gravity of the copper solution must be

taken by a hydrometer, and the quantity required for mixing with a given quantity of water ascertained. As there is risk of mistakes when this is done by labourers, it is safer to weigh out the same quantity of lime and copper, and measure the water each time in the proportions of 2 lbs. sulphate of copper, 1 lb. lime, 10 gallons of water, when little chance of mistake is offered.

Specific Gravity of Copper Solution.

For the preparation of considerable quantities of the mixture, the following plan, adopted for the Warminster plots, will be found convenient, and considerable time will be saved, but it is obvious that someone with intelligence should be present, to see that the proper quantities are secured.

Some days before the mixture is required, a paraffin cask, with the head taken out (or more than one, if the acreage to be done is considerable), should be placed upon a stage and fitted with a wood top. A short canvas bag is nailed to two strips of wood, so that it may be supported with the bottom about half way down the cask. The bag is to be filled with sulphate of copper crystals. The cask is then filled with water, and the suspended crystals will, in a few days, have dissolved almost to saturation point.

There is thus made a strong stock solution, which can be diluted as and when required.

A hydrometer should be provided for testing the strength of the solution, and the following table will be found useful as showing the strength, corresponding

to degrees of specific gravity, and the quantity of solution required for a given volume of mixture.

Table of Specific Gravity of Copper Solution.

Degrees of Twaddle's Hydrometer.	Specific Gravity.	lbs. per gall. of $CuSO_4+5H_2O$ in Solution.	No. of Gallons of Solution required for 40 gals. of Bouillie.
13	1·065	1·065	7·5
14	1·070	1·185	6·75
15	1·075	1·333	6
17	1·085	1·454	5·5
19	1·095	1·6	5
21	1·105	1·777	4·5
24	1·120	2	4
27	1·135	2·285	3·5
29·5	1·1475	2·461	3·25
32	1·160	2·666	3
35	1·175	2·909	2·75
38	1·190	3·2	2·5

Twaddle's hydrometer is recommended as a convenient and sufficiently accurate instrument to use. The cost is 1s. 6d., and it can be obtained to order to indicate the range of specific gravity required.

Assuming that a field of two acres is to be sprayed, if the stock solution is of 32 deg. Twaddle, about 24 gallons of this will be required, and can be drawn off, to be taken to the field.

The copper dissolves more quickly if it is ground to a powder. Sufficient copper may be dissolved at once to supply several quantities of solution, but the water must be measured so that the proper quantity for each solution may be measured from it as required. Before

taking out a given quantity, the solution must be thoroughly stirred, so that each lot is of the same consistency. A besom or old whalebone brush is the best stirrer.

The lime should be slaked at least half-an-hour before mixing. The copper solution is stirred into the required amount of water, and then, after it has been mixed with water to a creamy consistency, the lime is poured into it and well stirred also.

The lime is required to neutralise and precipitate the copper. If this is not thoroughly effected there is danger of cauterisation when the mixture is applied to plants. Lime varies in quality, and the burning is not always thorough, consequently it is impossible to state definitely how much lime should be employed, although when the lime is very good, 1 of lime to 2 of copper is found to approximate it. To ensure that the copper is neutralised, a solution of ferrocyanide of potassium (yellow prussiate of potash—a strong poison) can be used at the rate of 1 part of the crystals in 20 parts of water. If a drop or two of this be allowed to fall on the surface of the mixture there will be an immediate dark-brown colouration where the drop falls if sufficient lime has not been used. In this case more must be added. If there is no reaction enough lime has been used.

Coarse lumps of lime should be removed before being mixed with the solution, or they will tend to choke the machine.

When the hand machines are used the mixing is

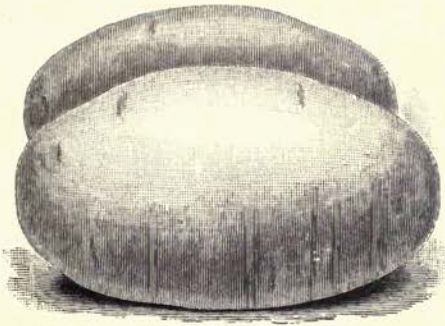
done similarly, but two mixing-tubs will be sufficient in which to prepare the mixture.

The quantity necessary to apply per acre varies from 80 gallons on a very young crop of small-topped varieties, to 200 gallons on strong, coarse-haulmed varieties. The cost of materials to make the solution is about 4s. for 100 gallons.

Use of the Sprayer.

The nozzles of the sprayer should be carried well down towards the base of the stem, and the nozzles should be turned upwards so that the spray may be directed to the under side of the leaves, where the attack is most commonly made. The spray should not be directed too vertically, or the upper leaves will not receive the spray. A slightly horizontal spray will affect the next row to some extent, but this will be counterbalanced when treating with the next row. If a horse-machine is carefully observed at work a cloud of spray can be detected, and this ensures all parts being affected. If the nozzles are placed too vertically the spray gets little opportunity of breaking, as it is driven bodily on to some part of the plant, and is to an extent wasted. A very thin film of the mixture prevents attack, but if it is too thick the stomata are blocked, and cannot fulfil their functions. When setting the nozzle it is important to notice that the spray does not expend itself on the ridges of earth, but on the rows of potatoes.

We find that by attaching two pairs of nozzles to



WEBB'S STOURBRIDGE GLORY.

LATE WHITE KIDNEY.

Introduced by Messrs. Webb and Sons.

CARTER'S MYATT'S PROLIFIC.

FIRST EARLY WHITE KIDNEY.

each lance, one about six or eight inches above the other, double the quantity of solution is applied advantageously, and with great saving of time and trampling of the land. We have adapted a 7-row Strawson to a double 5-row, and find the pump sufficiently strong.

The horse machines may be fitted so as to spray the upper portion of the leaves simultaneously with the lower. Mr. Barnes, of Moynalty, in his trials, found decided advantage in this method in those cases where the tops were very heavy and the spray had difficulty in working upwards through the dense foliage.

The spraying should be commenced earlier in the season than ordinary observation might indicate. It must be remembered that the disease has established itself several days, and, if the weather has remained cool and dry, probably some weeks before it is noticeable to the casual observer. It has been shown that the first attack on the crop is that which it is most necessary to guard against, as when the disease has once established itself in a field it cannot be entirely eradicated, and it is continually throwing off spores which are able to set up disease. It is therefore important to guard against attack, and spraying must be commenced early. There is no fixed date at which this should be done, as climatic influences affect the growth of the crop, and also of the disease. Seasons vary so much that there is often some weeks' difference between the growth on a given date in different years. As a general guide it may be taken that a good time for

giving the first dressing is as soon as the haulm has recovered from the bruising received during the moulding-up. In wet and warm seasons disease becomes apparent earlier than usual, and judgment must be used as to the advisability of spraying small plants. The necessity of commencing to spray early is increased by the fact that when the weather is continuously wet, and favourable to the development of disease, it is difficult to get about the crop and use the machine.

The number of dressings necessary to render the crop safe from serious injury is regulated by the nature of the weather and the power the particular variety has of resisting disease. In dry seasons one dressing will prove efficacious, whereas in wet ones three may be required. Varieties which are easily attacked usually require two dressings.

It has been suggested that one of the effects of spraying the plants with sulphate of copper might be to introduce copper into the tubers. Dr. J. M. H. Munro made special analyses in connection with the Warminster experiments with a view of ascertaining if this were correct, and reported as follows:—"Not a trace of copper could be discovered by the most delicate tests in the concentrated extract from over one pound of tubers (previously reduced to ash) from the various dressed plots."

Lysol.

It is hardly probable that sulphate of copper is the

NOT SPRAYED. SPRAYED.

Photograph by Lord Clonbrock showing the effect of spraying with Strawsonite to prevent potato blight.

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only substance which, while not injuring the plant, will render it unfavourable as a host to the fungus of the potato disease. M. Louis Sipière has recommended to the French Academy of Science that lysol, an alkaline liquid, prepared in Germany by the saponification of cresols, should be used as a remedy for vine disease. If this disease is checked by it there is little doubt that the potato disease would be also. M. Sipière's private trials have not yet been confirmed by public tests, but if they are there will be a gain in the discovery. As used in the proportions he recommends, it is 28 per cent. cheaper than the Bouillie Bordelaise. Other advantages are its easy solubility in water, and consequent simplicity of preparation for use. The quantities he recommends are 1,000 parts of water to four parts of lysol by measure, or five parts to 1,000 by weight.

Other Diseases of the Potato.

Several other diseases cause injury to the potato crop, but collectively they do not work so much devastation as *the* disease. The reason why the various diseases attack the crops so persistently, and more frequently than when the plants are growing under natural conditions, is doubtless due to some extent to the fact that when grown in large quantities the germs of diseases readily find a suitable host to attack; whereas, when the plants are isolated, the germs stand a much greater chance of not meeting with a plant suitable to attach themselves to, and finding no food

which will support them, die. This is noticeable in all cases of attack, whether of fungi or insects.

The *Fusisporum solani* is a fungus which attacks potatoes, particularly when grown in the southern and midland counties of England, though it does not appear to have been found in the north. It is by no means a recent introduction, having been noticed sixty years ago. It is frequently found growing in conjunction with the *Phytophthora infestans*, but is easily distinguished by its spindle-shaped spores. Another variety—*Fusisporum roseolum*—is often noticeable on decaying tubers, when it is seen in patches of rose-coloured mould. Spraying does not appear to have any effect on the disease, and the only recognised means of keeping it in check is to select sound tubers for planting, and to destroy those which are attacked.

Macrosporium Solani.

The fungus *Macrosporium solani* attacks the leaves of potatoes, and, under suitable conditions, destroys the plant. During the past few years it has been noticed in Great Britain, on the Continent, and in America. The attack is often not recognised from that of *Phytophthora infestans*, but closer examination reveals considerable differences. The *Macrosporium solani* generally attacks the under side of the leaf. At first a small greyish-brown spot is visible; this extends gradually, in concentric rings, and pieces of the leaf eventually fall out, leaving holes with ragged margins. The hyphæ, which appear outside the leaf, are brown,

somewhat curved and septate (jointed), whereas those of the Phytophthora are colourless and not septate. The conidia are oblong pointed, and divided by transverse and longitudinal septa, while in the phytophthora they are colourless and egg-shaped.

At present the full life-history of the fungus is not known, but it is probably an early form of some species of sphæria not yet recognised. The attack is made on the leaves, and does not reach the tubers, so it is assumed that the conidia rest on the decaying leaves and stems of the plants, or on the ground. The leaves, when attacked, gradually shrivel and die, leaving the stem bare; consequently the plant dies, or, in less severe attacks, loses its vigour and produces a proportionately small crop.

Although the life-history is not satisfactorily traced, it is known that spraying with the Bordeaux mixture prevents and cures the disease. The method adopted for preventing the ordinary potato disease is equally suitable in the case of the Macrosporium attack; in fact, when using the mixture to check the Phytophthora, there is no need to fear the Macrosporium.

The smut of potatoes—*Tuberania scabies*—is caused by an olive-green or brownish fungus, which attacks the haulm, causing blotches to appear on the skin; these blotches sometimes develop to such an extent as to merge, so that in time the whole of the skin is discoloured. In course of time the fungus, which has hitherto lived under the skin, bursts through, and gives off olive-green spores. The tuber itself becomes

affected, and one form of scab is produced. There is no known remedy for this disease. This attack is distinct from ordinary scab. The common form of scab—brown, somewhat cork-like blotches—on the surface of the tubers is usually ascribed to bruising in one way or another. The skin of the tuber is slightly abrased by the friction of the soil on it, which sets up irritation or excitement, causing a special rush of matter to the spot, which develops into skin. The stirring of the soil rubs it against the tuber, when the skin is tender and easily affected. When potatoes receive a check owing to drought, when the soil sometimes sets hard, the first rain is apt to cause the tubers to grow, although there may not be sufficient moisture to soften the ground. This causes special pressure on parts, which become abrased. The splitting of the stems is also attributed to mechanical causes.

Among other minor diseases may be mentioned the *Peziza postuma*, a fungus which pervades the plant, and shortly destroys it by exhausting the moisture from the leaves and stems, reducing them to tinder, to prevent which no means have yet been discovered.

The ordinary dry rot is produced by a fungus, as is also a more recently noticed form, called black dry rot. A peculiarity of the latter is that, when the apparently healthy portion of the tuber is cut, it assumes first a rust-red colour, which subsequently turns black. In some seasons a large quantity of potatoes suffer

from the dry rot; but, beyond the selection of the seed, no preventive means have yet been successfully applied. The wet rot is caused by certain species of bacteria, chiefly *Bacillus amylobacter*.

Insect Attacks.

Insect attacks on English-grown potatoes are most commonly directed to the destruction of the plant below ground. The Colorado beetle, *Doryphora decemlineata*, which caused a great scare in England a few years ago, did not find it a suitable home, though it still does great injury to American crops by eating the leaves. The insect is kept in check by means of a spraying of Paris green in solution, which proves very effective, and is commonly used in America and Canada.

The Potato Frog fly (*Eupterix solani*) is commonly found in England, but not in sufficient quantities to do serious injury. This insect attacks the leaves, sucking out the sap. It is very small, the wings, when extended, being less than a quarter of an inch in breadth, while the length of the insect is only about one-twelfth of an inch. The attacks have proved so unimportant that no steps have been taken to check it.

The caterpillar of the Death's-head moth feeds on the leaves of the potato, but fortunately it is not sufficiently plentiful to do serious injury, or from its great size it would rapidly devastate crops. This handsome caterpillar, four or five inches in length, is of a greenish yellow, speckled with black on the back,

and has seven slanting stripes of blue or lilac on each side. A stout, curved, and pointed protuberance, suggestive of a tail, emerges from the hindmost segment of the grub. Before changing to the chrysalis state it turns to a warm yellow colour. The moth is the largest of the British kinds, and is very handsome. The caterpillar is a night-feeder, and the only remedy suggested is to catch them by hand on light moonlight nights, when they can be easily observed.

The greatest loss occasioned by insects is effected by the surface caterpillars. Surface caterpillars include many varieties, of which those of the Dart moth, *Agrotis segetum*, and the Heart and Dart moth, *Agrotis exclamationis*, are the most common. Miss Ormerod describes the caterpillar of the Dart moth as being hatched from June to autumn. When full-grown they are about an inch or an inch and a half in length, nearly as thick as a goose-quill, and smooth, with a few hairs of a pale, smoky colour, but sometimes pinkish or purplish brown, and with two dark lines along the back, and one along each side. These lines however, are not always distinct. The head is horny, much narrower than the next ring, and is stretched out on a plane with the body; it is of a pale, dingy brown, with black jaws, ochreous eyes, dotted with black, and a cross-like mark on the face. The first ring brown, divided by three pale lines; on the other segments are four black dots (placed obliquely, two on each side of the central line), and three black dots at

the base of the thighs. Other surface caterpillars are very similar, and their general appearance is suggestive of a somewhat smudgy, dirty grub. The Dart moth has the fore wings of a pale grey ground colour in the male, dark umber in the female, with various markings. The hind wings are pearly white, clouded towards the hinder edge in the female, and with dark rays. The colour of the body (including the abdomen) varies, like the colour of the fore wings, with the sex. It is lighter in the males than in the females.

The injury caused by these caterpillars is chiefly done to the tuber, which they eat freely. Large holes are bored into the tuber, and, in course of time, these become so large that the insect lives inside them, continuing to increase the size by constantly feeding. In bad attacks the tubers become little more than a shell, and are spoiled for market purposes. Excepting the potato disease, there is nothing which can do so much damage to the crop as these grubs, and we have seen crops where fully one-half have had to be thrown out of market samples on account of them. Potatoes thus attacked are called "whistlers," and when moved make a rustling sound, suggestive of dry leaves in motion.

For no assigned reason the severity of attacks varies from season to season; land becoming infested from no apparent cause, and freed from them in an equally mysterious manner. They feed on almost any green crop, and show great partiality for turnips and similar crops. The worst attack we remember was on late turnips, sown after a crop of tares cut late in the season.

The grub goes down into the soil in autumn and turns into a chrysalis, forming a cocoon of earth as a bed. It is doubtless advantageous to break up the soil so as to expose them as much as possible to the influence of frost and wet, and to bring them in reach of birds. Many mixtures have been tried in the hope of destroying the grubs, but not with the success that might be desired. A dressing of gas-lime has been found beneficial. Hand-picking has been found useful but expensive; this, however, is more practicable in the case of turnips than of potatoes. Constant stirring of the land has a good effect, but, unfortunately, the damage is done to the potato crop when the tubers are forming, and are consequently moulded up. Starlings and plovers consume a great many, and rooks eat them to some extent.

The grub of the Yellow Underwing, *Noctua* (*Tryphœna*) *pronuba*, attacks the tubers in much the same manner as do the surface caterpillars, and frequently cause much injury. The caterpillar, the grub of the Great Yellow Underwing moth, is an inch and three quarters in length, and as thick as a stout quill. It is very variable in colour, generally of a sickly green or dull brown, with a dull brown band down the back, a pale line along the middle, and a short line of dark spots or streaks along each side. Underneath it is a pale green. They are fat, and dull in appearance. When exposed they curl up into a ring. They are night feeders, and the means of exterminating them are similar to those recommended in the case of the surface-feeding caterpillars.

Wireworms and Millepedes.

Next in importance, as causing injury to the growing tubers, are the several kinds of wireworms and millepedes. Wireworms are the larvæ of the genera of beetles known as *Elater*, *Athous*, and *Agriotes*, belonging to the large family of Elateridæ, but those which do the most harm to potatoes are species of the genus *Agriotes*—namely, *Agriotes lineatus*, *A. spectator*, and *A. obscurus*, and the worst of these is *lineatus*. The wireworm is the larva of the Click Beetle, and it is found that they remain in the grub state from three to five years before going down into the soil to change into the chrysalid form, from which, in a few weeks, the beetle emerges, or if late in the year the insect may lie in the pupa stage through winter. True wireworms have three pairs of short legs, one pair being placed on each of the rings, immediately behind the head, and they have also a sucker foot below the tail. They are usually of a yellow ochreous colour, with hard, shelly skin, and are most commonly met with extended at full length.

Millepedes, False Wireworms, Julus Worms, are names given to several worms somewhat similar in their destructive habits to the True Wireworms. They belong to the family Julidæ. Four species are commonly met with: 1, *Julus londinensis*, nearly an inch in length, is of a dark lead colour, cylindrical in shape, and is often found curled up; 2, *Julus terrestris* is rather larger than *J. londinensis*, though in other respects it is very similar; 3, *J. guttatus* is of an

ochreous colour, with a double row of bright crimson spots down each side, except on the four first and five last segments; 4, *Polydesmus complanatus* is flattened in shape, and not cylindrical, like the others mentioned. It is from ¼ to ½ an inch in length. All the millepedes are furnished with a large number of legs, giving the under side of the body the appearance of being fringed. The legs are less numerous when first hatched, but they increase in number with each moult. *J. guttatus* possess as many as 170 legs, *J. terristris* more than 150, when mature.

Wireworms and Julus Worms injure the potato crop in the same manner. As a rule the attack is made on the tuber, but occasionally on the stem below the surface. Occasionally they attack the sets so severely that the shoots cannot make their way through the soil. A striking instance of this came under our notice some few years ago. Mr. Douglas Summers, of Aspley, broke up a piece of rough ground which had not been tilled previously, and on this he planted potatoes. The potatoes were so long in coming up that he examined the sets, and found them absolutely infested with wireworms and Julus worms. Seeing there was no chance of growing potatoes or any other crop whilst the ground was overrun in this way, he had the whole of the potatoes taken out of the ground and replaced. Before replacing them, however, the insects were shaken into pails. Some idea of the quantity of worms captured in this way may be gathered from the fact that two pails full were

collected from between two and three acres. Since that time the land has been perfectly free from the worms. The expense was heavy at the time, but was undoubtedly profitable in the long run.

The manner in which the field was cleared of the pest is analogous to the practice of "trapping" wire-worms. Pieces of potato, mangel, carrot, or other vegetable, are placed in the soil in convenient places for them to be taken out from time to time. If there is no crop on the land they speedily collect to these traps, and may be destroyed. The Julus worms may be collected from traps laid on the surface. Decaying vegetable or animal matter is a great attraction to these, and vast quantities may be caught under small heaps. In gardens small quantities of night-soil buried a little below the surface are very attractive to the worms, and if taken out and burnt, after being left in the ground a few days, a great number of worms will be destroyed with it.

An unhealthy condition of the soil, from whatever cause it may arise, conduces to the increase of wire-worms and Julus worms. Want of proper drainage, giving rise to sourness in the land, is one of the most frequent causes of attacks. Personal experience has proved that land so infested with the worms as to render it unprofitable to grow potatoes on account of the injury done to the tubers may be cleared by drainage. One of the best fields we have at the present time affords an instance of this. Sourness of the soil, if due to want of lime, should be remedied at

once; and lime applied immediately after draining makes the operation more quickly effective Thorough working of the soil so as to induce healthy conditions is beneficial, and is further advantageous because it disturbs the insects, and brings them into reach of birds. The plover is the farmer's greatest friend in the destruction of these insects, and should be encouraged as much as possible. Rooks do great good, but they must be debited with injury to the potato crop, as they disturb the sets when placed shallow in the soil; they scratch out the young tubers, and in winter time in very severe weather do considerable harm by pulling off the litter laid on the pits to keep out frost. They are, therefore, not an unmitigated blessing. Starlings, partridges, and larks also destroy great numbers.

Potatoes attacked by wireworms are generally bored into in a straight line, suggestive of a prick with a nail. "Pin-pricked" is a term commonly used to denote the boring effected by the *Julus guttatus*, because the hole is suggestive of a prick with a fine pin. This pin-pricking is particularly annoying, as it is not visible from the outside unless very carefully examined for. A sample may appear perfect for culinary purposes, but if cut in two a blemish is found. All about the boring the tuber will cook dirtily, consequently the value is greatly impaired. Borings by larger worms are more easily detected, though similarly the plants about them are injured. Very often eelworms follow the worms, and may be

found by aid of the microscope. When holes have been made by grubs, wireworms frequently creep into them, and then they often feed by grazing on the flesh of the potato instead of boring into it.

Injury by Frost.

Frost affects the potato injuriously at several periods. Spring frosts, or, worse still, summer frosts, cause injury by destroying the leaves and haulm of young plants, sometimes cutting them so severely that they are entirely destroyed; at others causing only a temporary check. When grown on a large scale, little can be done to prevent injury. Moulding-up prevents the frost affecting them so far down the stem, but the crop is not always sufficiently matured to be moulded up. If a frost is expected immediately, care should be taken in moulding, as the bruising to which the tops are subjected renders them more liable to injury. Moulding-up should not be done late in the day if a frost is expected at night. When grown in gardens a covering of straw is commonly used to keep off the frost, and in all but the most severe cases proves effectual.

Freezing in the ground in autumn is by no means rare, and points to the necessity of getting the crop dug as soon as it is fit. The advantage of deep moulding is realised during these autumn frosts, as those exposed are more readily injured than are those deep in the soil. Those frozen should be kept apart from the sound ones, as they cause fermentation in the

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SUTTON'S FLOURBALL.

LATE COLOURED ROUND.

Introduced by Messrs. Sutton and Sons.

pits, and transmit decay to those which would otherwise keep sound. The feeding properties are not destroyed if they are fed at once, but they rapidly decay. They should be cooked. Freezing in the pits has been alluded to. Nothing prevents freezing in the pits so thoroughly as a covering of short straw or dung, laid over the pits when already covered by earth. It is necessary, however, that the straw should lie closely. For this reason strong, unbroken straw is not so effective, unless it is put on in the form of thatch.

Sea-Blight.

Somewhat allied to the injury caused to the growing plant by frost is that caused by sea-blight. Districts near to the coast are sometimes seriously affected by this, and its effect is noticed for a long distance inland when the blight is very severe. The atmosphere appears to be charged with an unusual quantity of saline matter, and is sometimes accompanied by fog and wind. Last year there was very severe blight, and this occurred during the severe frost in May. Other plants, especially evergreens, were much affected by it, and on these the injury was more particularly noticeable on the seaward side. There is practically no means of protecting large breadths of the crop from it.

SECTION IX.

DIGGING POTATOES.

The Fork.

Until within comparatively recent years almost all potatoes were dug or raised by the fork. The plough has certainly been used for a fairly long period, but in its ordinary form it is not well adapted to the purpose, though with the special breasts and raisers now fitted to it it is very serviceable under some conditions. Potato-raising machines, as those implements which stir the land in which the potatoes grow, and work them to the surface by means of revolving parts, are designated, have been used for a number of years, and are being improved from time to time. Hand labour appears very expensive, but under some conditions is the most profitable, as where the ground is hard the resistance is so great that the potatoes are bruised or crushed when raised by other implements. A great drawback to the use of the fork is the frequency with which the potatoes are pricked, especially in the case of those varieties where the tubers form at a distance from the stem. This entails considerable loss, because all those which are pricked are rendered unfit to be classed as best quality. Skilled labourers not only leave less undug than do those not accustomed to the

work, but they injure far less, as they instinctively know where the tubers lie in the ground. The short-handled four-tine fork is the best tool for the purpose of digging, and although flat tines are occasionally used in the place of the ordinary square or round tines, they are not so serviceable, as there is more likelihood of the tubers being struck or cut by them; nor can they be drawn through the loosened earth so easily; moreover, except on very hard ground, skilled diggers rarely force the spade into the soil by the aid of the foot, but strike it vertically into the ridge, and then force it to the required depth with the combined efforts of the arms and body. It is usually better to dig slightly across the ridge than immediately behind the plant in the middle of the row. The cost of digging and picking up an acre of potatoes, according to our personal experience, is from eighteen to twenty-eight shillings, making two selections—ware, or marketable size, and seed and chats, those which are not large enough for culinary purposes. As a rule, those which will not pass through a mesh one and a-half inches square are considered ware size; those which pass through a one and a-half inch mesh, but will not go through a one and a-quarter, are looked upon as seed; while the smallest, which fall through the one and a-quarter mesh, are called chats, and are usually used as food for animals about the farm. A crop of an early variety, such as Myatt's Ashleaf, which does not as a rule crop heavily, may be dug for eighteen shillings an acre, and allow the diggers to earn as much as they would get

when digging a heavy cropping late variety, such as the Wonder, at twenty-eight shillings, where the land is strong, and the potatoes difficult to free from the soil. Weeds are a hindrance to the diggers, as they impede the work. The roots of couch grass are most troublesome, as they form a network from which it is very difficult to shake the potatoes.

When digging potatoes with a fork the tubers should be kept closely together so as to facilitate the picking up. With this view, the tubers from three or four rows should be thrown by the fork into one line. Skilled diggers can collect the potatoes into a line of two feet in width without hindering their progress. As the cost of picking up the potatoes on an average crop exceeds that of raising them with the fork, it is obvious that it is important to keep them close together. Before picking up the tubers, the tops, haulm, or shaws should be gathered together and placed on one side. When doing this, the tubers should be shaken from them.

The Plough.

Raising potatoes by the aid of a plough fitted with potato breasts and raisers, is profitably done under some conditions. The plough should not be used when the potatoes are dug "green"—that is, when the skin is not firmly set—as it is easily rubbed off, thus spoiling their appearance and market value. Where land is very hard a considerable portion of the tubers are crushed in the operation, but on loose land the potatoes can be turned out quickly, and with little

injury. It is, of course, important to run the share well below the tubers, to avoid cutting them. If adjoining rows are ploughed out the potatoes in the one first ploughed must be picked up before the next one is ploughed, or a considerable quantity will be smothered and lost. To avoid this, it is best to work each alternate row, and after the potatoes are picked up, to return and plough out the rows left untouched. One objection to the use of the plough is that the tubers lie in a furrow, which renders it more difficult

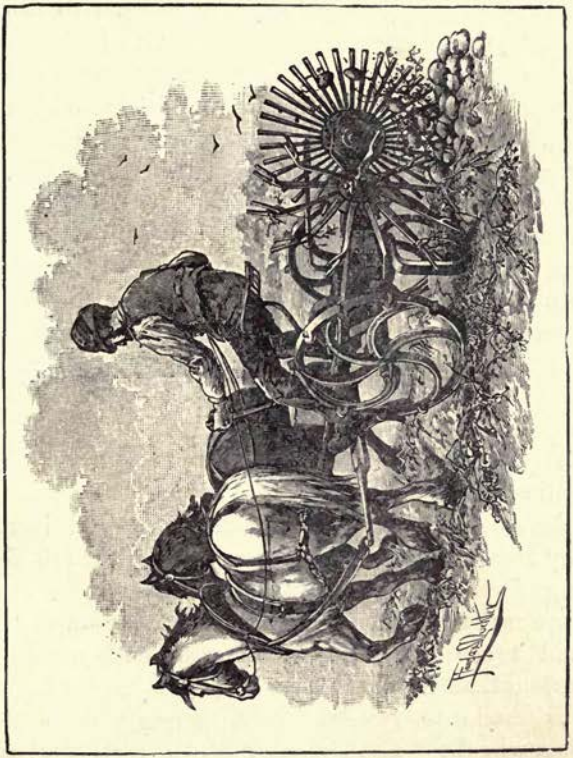
HOWARD'S POTATO PLOUGH.

and expensive to pick them up. According to the yield, from six to eight pickers are required to collect potatoes behind the plough. Where manual labour is difficult to command, the plough possesses decided advantages over the fork, for in some districts the crop would not be dug sufficiently early to ensure its being harvested before there was danger of its being injured by frost. There is no great saving in total cost if a value is put upon the horse labour, as picking up behind the plough is more expensive than behind the fork, and, except under favourable circumstances, more are left in the ground, but this is frequently more

than counterbalanced in those cases where labourers are few, and the crop would be left in the land longer than is safe. Potatoes are injured by being left in the land if it is in an excessively wet condition, as the cooking properties are destroyed, while severe frost occasionally destroys the whole crop, even in October. A value must also be set on the stirring the land gets, when so thoroughly moved by the plough. If weather is favourable, the potatoes which have been covered may be worked to the surface by means of the curve-tined drag harrow. In dry autumns the land may be rendered quite free from weeds in this manner.

Potato Raising Machines

Hitherto potato raising machines have been designed to raise the earth in the ridges by means of a share, so as to loosen it to permit a series of rotating forks to level them, and in doing so, to leave the potatoes exposed on the surface. These rotating forks are driven by gearing from the travelling wheels, and possess considerable speed and power, which throw down the ridges with sufficient force to impel them against a rack or screen hung a few feet from them. The force with which the earth is thrown against the screen shakes it clear of the potatoes, and these lie in a comparatively narrow row. As the ground is levelled, the picking up is easier than behind the plough. Very good work has been done by using the fork in conjunction with the raiser. When this is done the revolving forks are taken off the



POWELL'S POTATO DIGGER.

machine, and the share is run under the ridges, which raises and loosens them, rendering the working out by the hand-fork a very easy operation. As the land lies in a very light condition, there is no need to stick the fork into the ridges, but merely to shove it through them from side to side. This prevents injury by pricking, and effects a saving, because no tubers are damaged. The land is thoroughly worked, cleaned, and prepared for the subsequent crop. It is somewhat expensive, but the thoroughness of the work counterbalances this, especially where it is desired to take a catch crop afterwards.

Rotating blades, or turners, in the place of forks, have been introduced lately. With these the ridges are spread, and the potatoes brought to the surface by a scooping or shovelling action. The turners are not set directly at right angles to the ridges, but strike them flatly, thus avoiding much of the injury which would otherwise be caused to the tubers. The most recent development in these machines is that introduced by Messrs. Haslam and Maudesley. In this the revolving forks are entirely dispensed with. Two shares are made to run under the ridges, one on either side, and these lift the ridge, earth, and potatoes together, so that it falls into a long, conical cylinder, which is made to revolve by a gearing from the travelling wheels. The cylinder has a cage-like appearance, as narrow bars, placed at intervals, to allow the particles of earth to fall through, but sufficiently close to retain the potatoes, encircle a light frame.

Within the cylinder a series of helical guides, running from end to end, carry the contents to the rear or narrow end, where they are delivered through an opening into a basket. It is necessary to pull the haulm, and put it on one side, before commencing to raise the crop. The machine has not yet had an opportunity of coming into general use, but it has the appearance of being well contrived for raising and collecting the tubers at one operation, and if the cost of collecting is materially lessened it should prove a valuable addition to the potato grower's machinery. Not having seen it work we cannot bear personal testimony as to its efficiency, but though we should hardly expect it to prove highly successful on wet or sticky ground, we see no reason why it should not be worked economically on dry, loose soils.

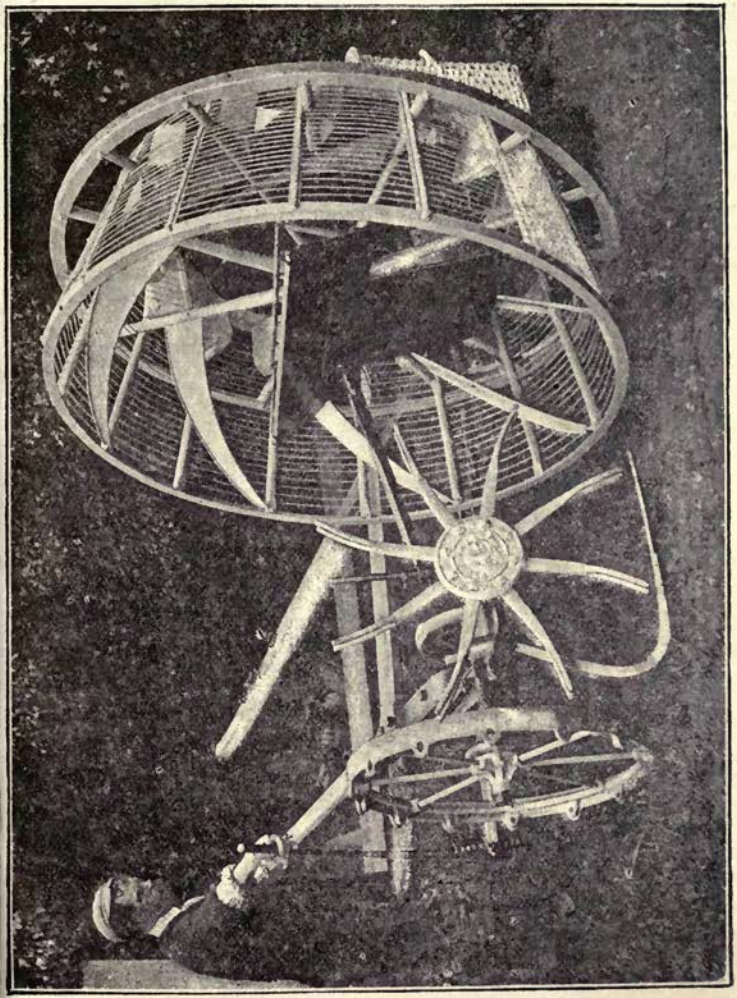
Picking up Potatoes.

Mr. W. J. Burgess has recently brought out an ingenious contrivance for picking up potatoes, called the Pioneer Potato Picker. A great advantage of this is that it can be adapted to any of the existing potato diggers. The collector takes the form of a large revolving screen, the framework of which is carried on two parallel wheels, one of which is stoutly made, so as to support the weight of the attachment and to cause the screen to revolve. The screening is effected through wires, fixed longitudinally on the frame, and these are embedded in india-rubber to prevent injury to the tubers at the joints. They may be set at any

required distance apart. The interior of the screen is fitted with guides, which conduct the potatoes into cups or pockets, which empty their contents into a trough as they revolve. Though attached to the digger, the collector works independently. The potatoes may be conveyed into sacks or a box, and delivered at will. The machine is newly introduced, but has been tried satisfactorily. It is, of course, best adapted to work on light, free, dry soils, where it doubtless saves much time in collecting the potatoes. On sticky or wet soils so good a result would not be obtained, but this may be said of other means of raising the crop. It is necessary to remove the haulms before commencing to dig, when the collector is used.

It is important to pick up all the potatoes, because those left in the ground, if diseased, may set up a fresh attack in the following year, and also because when another crop of potatoes is taken they will cause the crop to become mixed and of less value. When, from any cause, a portion of the crop is not picked up, an endeavour should be made to destroy them by frost during winter. With this view they should be worked to the surface as much as possible, and be left exposed.

It is advisable to pick up all potatoes on the day they are dug, as there is always a possibility of a frost coming on during the night. It is, however, desirable to allow the potatoes to dry before picking them up, if the weather is suitable, as they are less likely to become heated in the pits. All vegetables, such as



BURGESS'S PIONEER POTATO PICKER.

apples, mangels, and potatoes, sweat or ferment when collected together, but if they are in a dry condition, and air is allowed to circulate through them, dangerous fermentation is avoided. A special danger exists in the case of potatoes put together in a moist condition, because when they form part of a diseased crop the spores are shaken on them in the course of digging. These spores are harmless if there is no moisture present, but the heat, together with the moisture generated in the pit, afford specially favourable conditions for the development of the disease, and it is these causes which give rise to much of the "after-rot," or rotting in the pits. Tubers in which disease is more advanced also decay for the same reasons.

Digging "Green" Potatoes.

Potatoes are raised under two conditions—"green" or unripe, and ripe. When raised green it is necessary to sell them at once, as the skin is tender, and they are liable to injury from bruising. In addition to this the skin is rubbed off and the market value deteriorated. When dug green the object is to place them in the market as "new potatoes," and to realise the special prices which are usually obtainable in the early part of the season. The tubers increase very much during the period that the tops are dying down. As a rule, particularly in the case of the later varieties and those which carry a heavy haulm, at least one-third of the weight of tubers is gained from the time the tops reach maturity and die. Digging potatoes green

therefore involves a loss of yield which the grower expects to make good by the extra price he receives per ton. Occasionally, in special seasons, the potatoes continue to grow far on into the autumn, and it may be necessary to dig them when unripe, to avoid the risk of injury to the tubers by frost. In most seasons the plants mature naturally, and in others light frosts cut down the haulm and hasten the tubers to maturity, so that they may be dug before more serious frosts are probable. Any premature destruction of the haulm lessens the yield of tubers, but there are times when it may be advisable to destroy the haulm to hasten the ripening of the crop. For instance, when a heavy crop of tubers has formed, such as in the opinion of the grower will well repay him if harvested at once, he may think it desirable to hasten their ripening rather than leave them for a longer time at the risk of injury from frost. This is occasionally practised, but it should not be done without giving the matter full consideration. To treat a crop which has up to that time developed few tubers in this manner is absurd, as it would necessarily prove unprofitable, and it would be wiser to risk the frost, in the hope of obtaining a more profitable yield.

As the skin of green potatoes is always tender, and the market value is deteriorated when the skin is broken, the fork is, on almost all occasions, the most suitable implement to use for raising them. If, however, the soil is very loose, horse implements may be used. When the skin is very tender, the rubbing

which is occasioned in sacks is sufficient to break the skin, consequently they should be sent to market in skeps or hampers. When the skin becomes harder they may be conveyed in sacks, and when quite ripe, and the skin is firmly set, they may be shovelled, with a potato shovel, into a cart, and thrown loosely into the railway truck. So long as the skin can be easily rubbed off by pressure between the thumb and fingers it is absolutely necessary to convey them in hampers. A handful of straw, or more commonly of haulm, is placed on the top before they are fastened down to avoid injury by friction. The expense of conveying potatoes in hampers is very great, consequently it is advisable to watch them carefully so that the hampers may be dispensed with as soon as they are really in a fit condition to be put in sacks. Sacks are expensive, and saving is gained when they can be dispensed with, and the potatoes are conveyed loosely in the trucks.

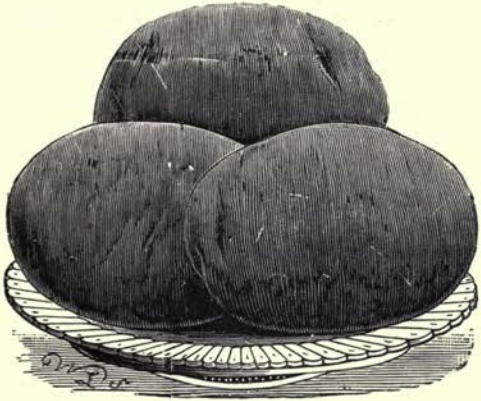
Pitting and Housing Ripe Potatoes.

Except in cases where the potatoes are placed on the market very early in the season, and such exceptionally high prices are realised that it is advisable to sell even the smallest, the seed potatoes should be stored at once. In gardens where small lots are grown they may be left exposed to the light, to allow the skin to become green and hard, but on a larger scale this is not convenient, and they keep sufficiently well if placed at once in the pits. Pits or clamps should be made above

ground. When made deep below the surface, water very often drains into the pit, causing injury to the potatoes. It is also much more difficult to work the potatoes out of pits, or to turn them when necessary. A greater depth than eight inches below the surface should not be allowed; this much is permissible. As a rule it is stated that the width at the bottom of a clamp should not exceed three feet. With this we do not agree, except in those cases where there is an exceptional amount of disease, or the potatoes are put together in a specially wet condition, and then the only risk is that of fermentation, which can be to a great extent avoided by providing good ventilation. Our own practice is to make the pits five feet broad at the bottom, so as to allow an ordinary farm cart to be backed up when being emptied. Having clamped some thousands of tons under both systems, we are so satisfied with the latter method that we never clamp them on less than a five-feet bottom. If the bottom of the pit is ploughed to the required depth, and the earth is cast on one side, this can be used for covering subsequently. A firm, level bottom should be made, so that the potatoes may be shovelled up easily when they are removed. The potatoes should be piled as high as they will conveniently lie on the base, forming a triangular section. Long potatoes, such as kidneys, stand more vertically than do round varieties, but on a five-feet base a ton weight will lie in a yard's length.

A thick layer of straw should be placed over the pit. Such a layer should be placed on it that when com-

pressed with earth it is at least six inches in thickness. Earth to the thickness of six inches should be laid over the straw. The earth keeps the straw dry and prevents the wind from blowing through it. In very exposed situations the pit should be additionally preserved by an outer layer of straw. A thick thatch of straw is very effective, but perhaps a coating of dung is best. Straw, laid loosely on the pit, does little good, as the wind draws through it very easily. It is better when damped and softened, and it is for this reason that freshly-made farmyard manure, or straw which has been trodden in the yards, without having become dung, is so useful. Although the outer layer of straw should be damp, the inner layer should be dry. The temperature within the pit may fall considerably below freezing point without freezing the potatoes, provided the potatoes are not damp on the outside, or in contact with moisture. But if potatoes lie damp, or damp straw lies upon them, they are very quickly frozen. If water drains into a pit the frost will follow it to the middle or bottom of the clamp in severe seasons. It is for this reason that ventilating holes should be closed as soon as fermentation has ceased. It is important that ventilation is provided when the pits are first covered. Small openings should be made on the ridge, and a good handful of the straw covering be partly withdrawn. This will afford an escape for the heated air, but within a few days fermentation will cease, and there will be no good in keeping the holes opened. On the other hand, great injury may be



SHARPE'S VICTOR.

FIRST EARLY WHITE OVAL.

Introduced by Messrs. Sharpe and Co.

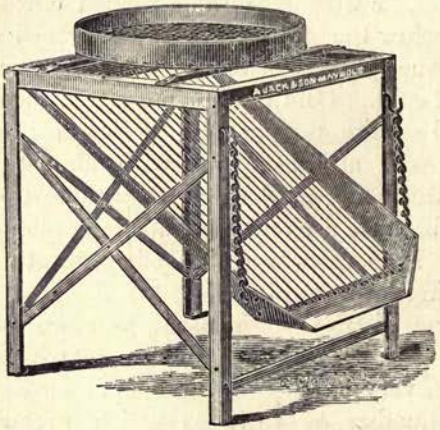
caused by keeping them open, as they admit cold and wet. Great injury is sometimes caused by wet and snow in winters when these alternate with frost. The snow melts and drains into the pit, and we have seen many instances where the whole of the potatoes which have been wetted have been spoiled from the top to the bottom of the pit. A safer method of ventilating is to insert small chimneys, covered at the top and perforated at the sides, or with mushroom-shaped cowls, with an opening below the cowl. At the approach of winter, openings such as these should be closed, to prevent the ingress of cold. Cold is often admitted through rats' holes, and as the temperature is warmer inside than out, the cold air rushes in with almost incredible rapidity, this being accelerated when there are a number of holes, because a circulation of air is set up through the pit. It is therefore highly important to prevent rats getting into the pits.

In some districts it is usual to store potatoes in potato-houses. This is suitable, except where potatoes are grown very extensively. A small acreage—unless a large number of varieties which require storing separately are grown—may be secured, at a moderate cost, in this way, but when the acreage is large, and a number of varieties are grown, the cost of permanent buildings is scarcely warranted. Unless the walls are so thick that frost never gets through them, the potatoes should not be allowed to recline against them, or they will be frozen. A layer of straw or of boards will prevent their freezing. It is also necessary to

cover them on the top, to keep them from turning green. Where they are laid very thickly, ventilating shafts may be inserted occasionally to allow the escape of moist heated air during fermentation.

Treatment while in the Pit.

If potatoes are left in the pit for a long time, they



JACK'S POTATO SORTER.

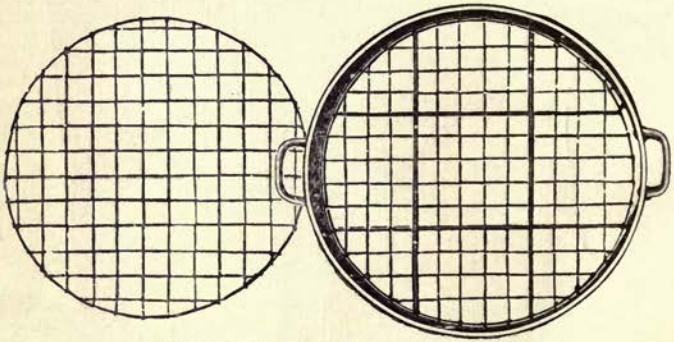
must be occasionally examined, as decay, from one cause and another, may set up. If there was much decay in the crop at the time they were dug, they should be examined frequently during the first few weeks, as it is probable that it will develop. The extent to which the disease develops regulates the necessity for prompt measures being taken. If the

disease is very bad the decay is likely to be conveyed to those which are sound, as the rotting sets up fermentation, which develops heat-moisture, conditions

COTTON'S POTATO SORTER.

under which decay is likely to progress. The whole mass should be moved, and the unsound ones taken out. There is no more rapid method than to work them on sieves or riddles. A stand on which to rest

the sieve is necessary for this, and the one we have used for years is both inexpensive and useful. Such a separator is used when sorting the potatoes for sale or other purposes. When used in conjunction with a hand sieve three separations are made: the ware remains in the middle, the seed passes down the shoot, and the chats and dirt pass between the tubes of the shoot. Another excellent separator is that made by



COTTON'S INTERCHANGEABLE RIDDLES.

Messrs. Geo. Cotton, to whom the Silver Medal was awarded by the Royal Agricultural Society, for their adjustable riddles. This also makes three separations. By a simple process, and with inappreciable delay, fresh meshes can be substituted in any of the frames, whether of the ordinary handle riddle, or in the complex machine. Several other machines, which make equally good separations, are in the market, but we prefer the two mentioned, because the mere division

into various sizes does not render the sorting complete. If the potatoes were perfect—that is, free from disease or blemish—some other machines would prove more expeditious in their work, but unfortunately this is barely the case, and sorting must be done by the hand, guided by the eye. Another advantage is that the riddles yield when the potatoes are thrown on to them, thereby saving them from bruising. They are also convenient for transport, and of convenient height for men to work over.

Turning Potatoes.

When potato pits are being turned, because of the presence of decay, much of the rotten portion is shaken out. When they are worked on the riddles, any which is not, must be picked out by hand. As separations are made in the process, the several classes thus obtained should be re-pitted in different pits, so as to facilitate work in the future. Potatoes which are pitted in a dirty condition, benefit by being turned as soon as the dirt dries, for then much of it is knocked off, rendering them more marketable.

If the potatoes are to be kept for a long time, it is necessary to turn them, to prevent them shooting. Some early varieties require turning more than once, otherwise they are spoiled for cooking, or the shoots extract so much of the contents that they are weakened, and the remaining shoots have so little food left for their sustenance that they produce enfeebled plants when used for seed. Labour is

profitably employed thus in winter, when work is otherwise scarce. Care, however, must be taken that the pits are not opened when the weather is so severe that the potatoes are frozen.

Sorting Potatoes.

When the pits are opened with the view of turning them, or for market purposes, the covering should be carefully stripped off. The potato sorter should be placed close alongside, in such a position that the potatoes can be easily thrown on to the riddles. A potato shovel

POTATO SHOVEL.

is the proper tool to use, as by its construction the potatoes are shovelled up without being cut, and from its scoop shape, a large number are retained in it. When the potatoes are being put up for market, baskets or skeps, which hold a bushel, should be used to fill the sacks. A market bushel is 56 lbs. weight. This is about as many as can be piled on the ordinary bushel. In some localities other weights than 56 lbs. are recognised as a bushel, but the large markets recognise the half cwt., which is most convenient in all ways. A small pair of scales, convenient to move, and on which sacks can be easily lifted, is required to take the correct weight. Sacks of potatoes are rather

difficult to handle, and when lifting them into a cart, the most convenient way to do it is for two men to work together. The man on the left side of the sack should grasp the top with his right hand, and the man on the right should grasp it with his left. Then a stout, short stick should be passed behind it, and held against it, rather below the middle, by the two men. The sack should then be allowed to fall on the stick, and with but little effort the sack may be carried or pitched on to the cart. Owing to the way in which a sack of potatoes usually flops over, when lifted by ordinary means, two strong men usually have to struggle to pick it up. In loading a large number of sacks, the advantage of the plan recommended is soon appreciated.

Yield of Potatoes.

Owing to the preferential rates granted by railway companies to foreign growers of produce, the English growers do not benefit so much by their nearness to the home markets as might be expected. Less than fifty miles from London the rate charged to us is over 6s. per ton, when carried loose in trucks; but when sent up green, in skeps, the price is relatively much higher, the carriage, with salesman's commission, amounting to 25s., or £10 per acre on an eight-ton crop. There is naturally a desire to sell as many as possible locally; but, except in the neighbourhood of large towns, this is a very restricted quantity. Occasionally fields of potatoes are sold to dealers, who buy

them with all risks, to dig and market them. Those experienced in growing can usually estimate the yield fairly closely, but those less accustomed to estimating them are often very far out in their guesses. As a rough guide, when the rows are 27 inches apart, and the plants 15 inches from each other in the rows, each tuber about the size of a lawn-tennis ball that is found at the root represents a ton per acre. Thus, if after digging a number of plants of average growth, the average number of tubers of this size is seven, the yield is probably about seven tons per acre. Larger ones give a correspondingly larger increase, and smaller the reverse. If a large number of plants are missing, so that frequent gaps occur, these must be brought into consideration. If the crop is not mature the probable increase must be borne in mind. The yield of potatoes varies very much in accordance with the variety, and the treatment the crop receives. It is stated that as many as thirty tons have been grown on an acre, but we have never seen twenty on a large acreage, and have no recollection of seeing more than fifteen in open field cultivation. On the Warminster trial plots the rate of over twenty tons has been grown in some instances. Where very heavy crops are grown a large proportion are so big that they are only saleable as "bakers' stuff," for mixing with flour in the manufacture of bread; as "baked potato stuff," for baking by "all hot" men, who sell them from street ovens; or as cattle food. For these purposes they have less value than "seconds." Consequently, though

bulky, the crop is not necessarily highly remunerative. Few growers average ten tons all round, taking a number of seasons together, as frost, disease, insects, drought, and other causes, tend to reduce the yield very materially. Where a fair proportion of early varieties are grown in the open, the yield is not often over seven tons. When the large number of unskilled growers are taken into consideration, and the various hindrances to development, which are so frequent, are remembered, it is difficult to believe that the average yield of saleable potatoes actually planted exceeds six tons per acre, and we believe it to be less. Such a low estimate should not, however, prevent those who are about to sell a standing crop from estimating the individual crop to the full. For all that, it is amusing to hear those who have no previous experience in growing on a large scale estimate the yield of their crop. We have frequently heard double the actual yield guessed, the basis of the turnip crop being taken; but another tale is told when the crop is sent to market.

SECTION X.

THE COST AND FEEDING VALUE OF THE CROP.

The Cost of a Crop of Potatoes.

The cost of producing a crop of potatoes varies very much according to the circumstances under which it is grown. Sometimes, as in the case of the lazy-bed system, as carried out in the west of Ireland, the work and expenses on the crop are small—so is the yield. The outlay is confined to the cost of digging once, planting, covering, seed, manure, rent, and digging. No cleaning is done, and the work, together with the items mentioned, would be worth about £9 per acre. The yield is small, and if disease appears a famine is easily established.

An almost equally careless manner of planting is followed in some parts of England, the labour being confined to ploughing in the potatoes when the land is broken up, some little work on the surface subsequently, moulding-up and digging. Other methods are extensions of this, with various alterations and additions. The condition of the land with regard to its cleanliness, fertility, and friability, regulate the amount of work and manure necessary to devote to it. Therefore, in estimating the cost of a crop, these must be borne in mind. A calculation as to the probable cost of growing

a crop may be made on the following figures, which are representative of the cost of growing a full crop on a medium loam, in moderate condition in respect to cleanliness and fertility:—

	£	s.	d.
Autumn ploughing...	0	12	0
Spring ploughing	0	8	0
Spring stirring, scuffling, harrowing, etc. ...	0	10	0
Marking out for planting...	0	1	0
Planting	0	7	6
Manure	5	0	0
Seed, at £3 per ton...	1	16	0
Harrowing, hoeing, horse-hoeing	0	10	0
Moulding-up...	0	3	0
Spraying	0	14	0
Digging and carting to station	1	10	0
Rent	1	5	0
	£12	16	6

If the potatoes are not sold at once they require pitting, and this, with covering, will cost as much as is allowed for carting a short distance to the station. By holding the potatoes through winter a considerable increase in the cost is added. The cost of pit work is governed very much by the condition in which the potatoes are at the time they are pitted. If they go in sound and dry the expenses will be light, but if there is much disease, many of them malformed, grub-eaten, or injured in digging, the cost of sorting them is very considerable. If they are in pretty good condition it will take one man to fill the sieves, one man and two or three boys picking out inferior stuff, and one man putting up, weighing, and uncovering pits. According to the condition, from five to ten tons may be put up in

a day, at a cost of 10s.; to this must be added the cost of horse, cart, and man, taking to the station, and loading on truck, another 6s. If, however, the potatoes are both dirty and diseased, the expense is greatly increased. At the time of writing this we have eight men at a pit where the potatoes were grown on strong land, which was wet from heavy rains at the time of digging, and they cannot rub off the dirt and make two tons marketable in a day. On a ten-ton crop, on winter wages, this cost at the rate of £4 per acre. An extra cost of 16s. per acre is incurred, under most favourable circumstances, if the potatoes are pitted; and as has been shown, it may amount to £4 or more per acre when things are unfavourable. The cost of cleaning is not incurred because they are pitted in a dirty condition, for had they been sold when dug it would have been necessary to clean them, but the expense must be added to the cost of producing an acre.

Variations in Cost of Crop.

A shrewd and capable farmer is able to make a saving on some of the items given in the list of costs, which another, less skilled, might increase. As a rule we save some of the cost of working by using the steam drag harrows in spring. Planting by the aid of potato-planting machines, if slightly less accurate, reduces the cost per acre; but, of course, there is the first expense of purchase of the machine to be considered. The cost of manure is one which is subject to alteration. Less may be used if the land is in good

heart, or if artificial manures are employed. The spraying may be omitted, though our experience is in favour of continuing it. Digging is subject to alteration. With harvest wages, when the potatoes are dug green and picked up, and the different classes of quality are kept separate, the cost of digging, without the expense of carting to the station, may amount to £2 per acre. On the other hand, the cost of digging a very light crop may fall as low as 18s. per acre. Rent is, of course, not a fixed rate, but varies with the quality of the land. The cost of seed varies according to the popularity and supply of the variety grown, and average price of potatoes in the market. The price of potatoes varies considerably from year to year, and while in some, seed of popular varieties may not be worth more than £2 per ton, in others it may be well worth £4 or £5 per ton. Seed of early varieties, which are more liable to disease, and are most often affected by frost, varies in price much more widely than that of late kinds, and a difference of several pounds per ton frequently occurs in the course of a year. New varieties of great promise are much more expensive, as, when first introduced, they often fetch 70s. per cwt., though this falls rapidly to 10s. or less as the stock gets more widely distributed. The high prices are warranted, because the seed from these varieties sells well in the following year.

The Feeding Value of Potatoes.

The value per ton of potatoes has fallen considerably,

since so much additional land has become available to their cultivation that the large profits of the palmy days of corn-growing have gone. A larger proportion of those grown have to be disposed of in other ways than for culinary purposes. With a larger acreage than is actually required for domestic purposes, those which are of poor quality cannot be disposed of so advantageously in the market as on the farm. Carelessness and ignorance in the cultivation, and the growth of inferior varieties, keep the market glutted with potatoes of poor quality, and profit is only found where other conditions prevail. A few years ago, when wheat was more valuable, rough potatoes were eagerly purchased by bakers, but many of those who used to urge that good bread could not possibly be made without potatoes, find that, now wheat is only worth £1 or so per quarter, potatoes can be dispensed with. With few exceptions the bakers were not buyers of good quality, so now that their demand is lost, third-rate potatoes are either sold at a price which does not pay, or they are used as food for stock on the farm. The winter feeding value of all bulky fodder crops, especially those which decay quickly, is very dependent on the supply of turnips. Swedish turnips are sometimes worth a pound a ton in dry, cold springs, while in others they are hardly worth carting away from the farm. Generally speaking, however, they have a value of about 10s. per ton. The average quantity of water in a swede is 89 per cent.; of carbo-hydrates, 7 per cent.; of albuminoids, 1·4 per cent.; of fats, ·03. The

average in the potato is 75 per cent. of water, 20 per cent. of carbo-hydrates, 2·2 per cent. albuminoids, and fats ·03. Casually observed, a ton of potatoes contains nearly three times as much starchy matter, and nearly twice as much albuminoid; consequently the analytical feeding value of the potato is far more than twice as great as that of the swede. In actual practice, however, the analytical value of green fodder crops is not the only factor to be considered. The bulk of material is of great importance. Roots like straw and hay have a special value, as an animal fed on highly concentrated food containing all the necessary constituents analytically, will starve, not because of insufficiency of nourishment in the food, but because the animal cannot digest the food. Digestion cannot proceed properly unless the stomach is well distended, and bulky foods of low feeding value are most suitable for this purpose. A farmer cannot feed his stock entirely from the granary, but he has to go to his pastures for hay, and to his arable land for roots. Roots or potatoes are most valuable on those occasions when the stock of bulky food is short. At these times a ton of potatoes, containing more feeding value than two tons of swedes, is of less value than the swedes. The water contained in green crops is analytically exactly the same as pure water from any other source, but in some unexplained way it acts more beneficially on an animal. Take, for instance, a rich pasture on which cattle fatten in summer without any outside assistance, then try to feed animals on the

hay from the same pasture, supplying the water in the bucket instead of in the form of natural juices, and a far different result is obtained. The animal will not starve, at the same time it will not fatten, no matter how much hay and water are given it. Yet, analytically, water is the only constituent lost in the practice of haymaking. Treating entirely from the other side of the question, the carbo-hydrates, albuminoids, and fats can be supplied more cheaply in the form of cereals and other concentrated foods, than from potatoes. Taking wheat, for instance, the units of feeding matter, multiplying the albuminoids and fats by 2½, are 108, against 26 in potatoes, and the albuminoid ratio is 5·05 against 9·4, in which the inferiority of potatoes is shown. Thus, on analysis, if a ton of swedes is worth 10s., a ton of potatoes is not worth more than 15s., because, practically, equal feeding matter is contained in—

1 ton of swedes at 10s. per ton	...	£0 10s.	
¼ ton of wheat at £4 per ton ...	...	£1 0s.	
			£1 10s.
2 tons of potatoes at 15s. per ton	...	...	£1 10s.

In this the value of the extra succulence in the two tons of potatoes is not estimated, though that value exists. The moisture in a ton of swedes is 89 per cent.; in wheat 15 per cent., or an average per ton of 52 per cent., though the moisture in wheat cannot be considered as a natural juice. In potatoes the average is 75 per cent. As natural moisture is valuable, this puts the potatoes in a more favourable

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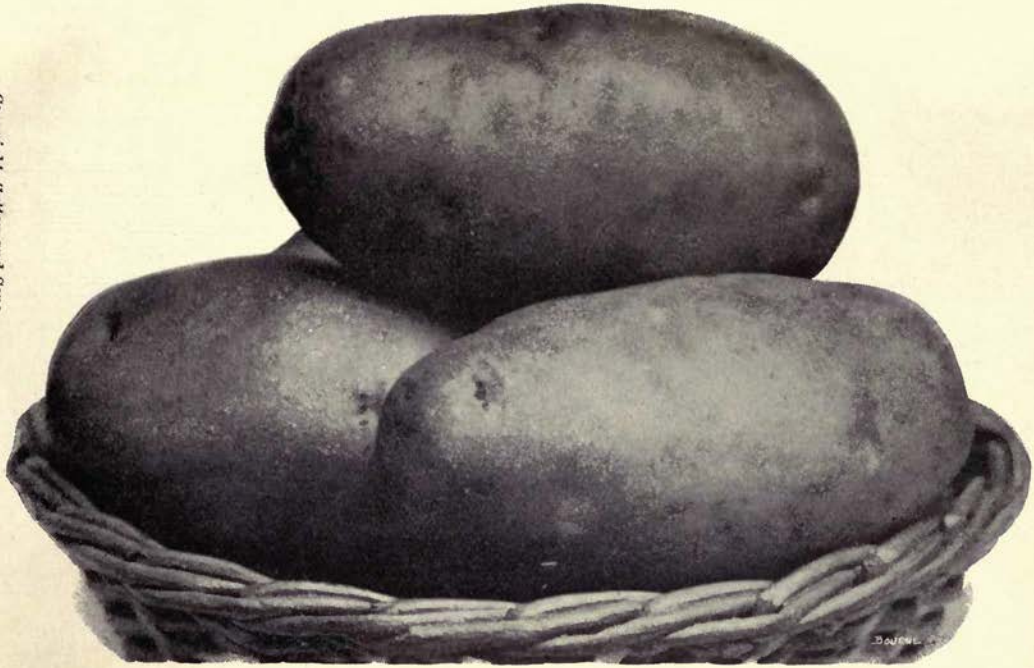

SUTTON'S MAGNUM BONUM.

LATE KIDNEY. WHITE.

Introduced by Messrs. Sutton and Sons.

position than swedes, but against it, when considering the value of the crop, must be placed the turnip-tops, which have a value for feeding not possessed by potato-tops.

The cost of producing a crop of potatoes and a crop of swedes must be taken into consideration. Without going into the details, experience shows that it is easier to grow 25 tons of swedes than 12½ tons of potatoes; or 40 tons than 20 tons of potatoes. Beyond this the full feeding value of the potatoes is not obtained, unless they are cooked, which involves extra expense. In the case of sheep, large quantities of raw potatoes produce scour; in pigs and horses indigestion.

It is our personal experience to have had to feed large quantities of potatoes, which have been injured in one way or another, so as to spoil them for market but not for feeding purposes. This experience confirms the previous calculations, and we would more readily feed two tons of swedes than one ton of potatoes. We have gone into the subject of the relative feeding values of the two crops, because results of a few experiments are frequently taken as data to show the exceptional value possessed by potatoes as a fodder crop. Experience shows us that there is no special advantage to be reaped by substituting potatoes for swedes as a crop, nor is it more profitable to buy potatoes at double the cost per ton that would be paid for swedes at the same time. Our contention is that remunerative potato culture is most likely to be obtained by growing potatoes which, from their better

quality, will realise the highest prices for culinary purposes. In doing this there will always be sufficient spoiled and inferior ones among them to supply the wants of those who are open to purchase poor quality.

Feeding Damaged Potatoes.

Although potatoes are not possessed of such exceptionally valuable feeding properties as to place them as a crop beyond all other root crops—for cabbages yield on similar treatment more feeding value per acre even than swedes—their value cannot be ignored, and it is fortunate that they possess it to so great a degree as they do, for this prevents the loss which would be incurred when they cannot find a sale on the ordinary markets. Those potatoes which still remain firm, although attacked by disease, are also valuable as food for farm stock and for the production of starch. There is practically little loss of feeding matter in the tubers until decomposition has gone so far that the diseased portions go pulpy. The disease first affects the structural parts; consequently, if they are at once consumed the full feeding value is obtained. They should, however, be cooked. This makes them more palatable and more digestible, and at the same time totally destroys the disease. As dirt is commonly found adhering to them, and the soft, pulpy parts are best taken out, they should be washed. The cylindrical root washer is the most effective cleaner, but a cheap arrangement can be made by placing a loose wooden

grating in a tub, or, better, long trough. Fill half the trough with water, place the floating grating on this, then throw in the potatoes, stir and rub them with a besom, or hard brush, and in a short time the potatoes will be cleaned, and the dirty parts will have sunk below the grating. If the cooked potatoes are allowed to dry, and are then tightly rammed into an air-tight tub, or bin, they will keep good for a long time. Cooked potatoes are readily eaten by all kinds of stock, and poultry thrive on them. They are particularly suitable for horses which are being got up for sale, as they give a sleek appearance to the skin and a brightness to the coat.

Specific Gravity of Potatoes.

The specific gravity of the potato is a guide to the amount of feeding matter contained in it. Dr. Munro and Mr. E. S. Beaven, hon. sec. to the Wilts C. C., under whom the Warminster experiments have been conducted, make the following remarks on the specific gravities of varieties experimented upon:—

"TABLE OF OBSERVED SPECIFIC GRAVITIES.

Varieties.	Observed Specific Gravity.	Calculated Dry Constituents per cent.
Imperator	1·115	27·5
Simson	1·110	26·4
Triumph	1·105	25·3
Andersen	1·103	24·8
Sirius	1·103	24·8

Varieties.	Observed Specific Gravity.	Calculated Dry Constituents per cent.
Renown	1·103	24·8
Abundance	1·100	24·2
Schoolmaster	1·099	24·0
Windsor Castle	1·097	23·6
Stourbridge Glory	1·097	23·6
Reliable	1·095	23·1
Surprise	1·095	23·1
Blue Giant	1·095	23·1
Bruce	1·095	23·1
White Elephant	1·095	23·1
Perfection	1·094	22 9
Satisfaction	1·094	22·9
Dreadnought	1·094	22·9
King of the Russets	1·093	22·7
Early Crimson Flourball	1·093	22·7
Colossal	1·093	22·7
Reading Russet	1·091	22·3
Cosmopolitan	1 090	22 0
Main Crop	1·088	21·6
Supreme	1 086	21·2
S. Seedling	1·086	21 2
Holborn Abundance	1 086	21·2
Reading Giant	1 085	20·9
The Daniel	1·085	20 9
Webber's Early Beauty	1·080	19·7

" The above specific gravities were taken by Mr. E. H. Smith in the following manner:—A solution of common salt in water was prepared, of a specific gravity of about 1·150. Twelve tubers, taken at random from each variety and cleaned, were immersed in the solution, and water added until one-half of the tubers sank and the other half remained suspended. The specific gravity of the brine was then

observed with a hydrometer graduated to single degrees.

"This is not an absolutely accurate mode of observation, but the labour and time involved in making estimations of specific gravities with the specific gravity balance, renders this method impossible when a large number of determinations have to be made, especially as it is absolutely necessary to take a fair number of tubers from each variety to obtain an average. As a matter of fact, it is frequently observed that the differences in the specific gravity of tubers of the same variety, and even from the same plant, vary more than do those of different varieties. By taking not less than twelve tubers of average size, it may be assumed that at any rate approximately correct results are obtained. The temperature of the solution should, theoretically, be constant at 60 deg. throughout the experiment; but here, again, the variations are not such as to appreciably affect the results obtained by the immersion method.

"Having obtained the at any rate approximate specific gravities of the different varieties by this means, it remains to interpret the results.

"The first eight varieties of the thirty-one with highest specific gravities 1·100 and over, are all round sorts, and the order, with one or two exceptions, is from late to earlier sorts, the later being of the higher specific gravity. The last eight sorts, 1·090 and under, are all of the kidney type. The earliest variety of all (Webber's Early Beauty), and that which gives the

lowest yield, is of the lowest specific gravity; and the variety (Imperator) which gives the heaviest yield, and is almost the latest, gives the highest specific gravity.

"The differences in the specific gravity of tubers, assuming that there are no cavities in those taken for the determinations, depend on the varying proportions of water and of dry constituents respectively contained.

"It is probable that these variations are this year greater than usual, in consequence of the drought, which has affected some varieties more than others, the variations so caused being also, perhaps, connected with the relative leaf surface from which evaporation takes place.

"The average percentage of water in potato tubers is about 75, the extreme variations with different varieties and different cultural conditions, being between 68 and 82, or between 32 and 18 per cent. of dry, solid matter. So far as the writers are aware, estimations of the specific gravity of different varieties of potatoes, with a view to determining their relative value for feeding or other purposes, have not been made to any extent in this country, probably because the tuber is not largely used here for cattle-feeding purposes or for the manufacture of starch or spirit, to which latter purposes it is largely put on the Continent. In view of the probability that heavier crops of field potatoes may be grown in this country in the future, through the introduction of disease-prevention remedies and later and more prolific varieties, and that the tubers may

therefore come to be more generally used for pig and cattle feeding, it is desirable that more attention should be paid to this subject.

"The *dry* solid matter of potato tubers has an average composition as follows:—

Starch	82·2
Albuminoids	10·1
Fat	·5
Fibre	2·7
Ash	4·5
	100·0

"The specific gravity of these compounds is only approximately known. Their respective percentages vary in different tubers, and only an approximate deduction of the weight of contained dry material can therefore be made from observed specific gravities of tubers. From a number of determinations of dry material made by the Warminster investigators, it appears that the mean specific gravity of the solids is near 1·600, and the table given is made by the adoption of the following formula:—

$$\frac{1{\cdot}600 \times 100\ [(\text{sp. gr. tubers} \times 1000) - 1000]}{(1{\cdot}600 - 1)\ (\text{sp. gr. tubers} \times 1000)}.$$

e.g., in the case of Imperator the percentage by weight of dry constituents will be:—

$$\frac{160 \times 115}{\cdot 6(1115)} = 27{\cdot}5.$$

"The values so arrived at are given in the column of the table headed 'Calculated Dry Constituents per

cent.,' and from these percentages the value of any given yield per acre can be reckoned.

"The difference between Imperator (27·5 per cent.) and Reading Giant (20·9 per cent.)—to take two typical, late, heavy-cropping varieties, one round and one kidney—is no less than 6·6 per cent. In other words, the difference between two crops, each of 20 tons of tubers, showing these specific gravities respectively, amounts to 26 cwt. of dry solid matter.

"In 1892 the specific gravities of the ten varieties grown ranged from 1·0935 to 1·0807, Imperators being then also the highest, and all the round varieties higher than the kidneys. The variations were in 1893 very much wider, and the higher specific gravities are very much higher than any shown in 1892, but the variation shown in ordinary years is well worth taking account of, although it may not amount to one-half of that shown in 1893.

"If the values deduced from the observed specific gravities are to be relied on, it is possible to go further and compute the weight of digestible matter contained in crops of different varieties.

"Wolff's experiments in Germany are very generally accepted as yielding correct nutritive values for different feeding materials. In the experiment with pigs it was found that they digested 98 per cent. of the starch, or 94 per cent. of the total organic matter of potatoes. It would appear, therefore, to be quite safe to assume that 90 per cent. of the total dry constituents of the tubers are digestible. As a matter of

fact, the percentage is almost certainly higher than this. At this rate Imperator gives 24·7 per cent. digestible matter, or 4 tons 18 cwt. on a crop of 20 tons."

The specific gravities, and the amount of digestible nutritive constituents, would differ from these to some extent were the potatoes grown on peaty or boggy soils, but these afford a fair illustration, being grown on moderately dry loams.

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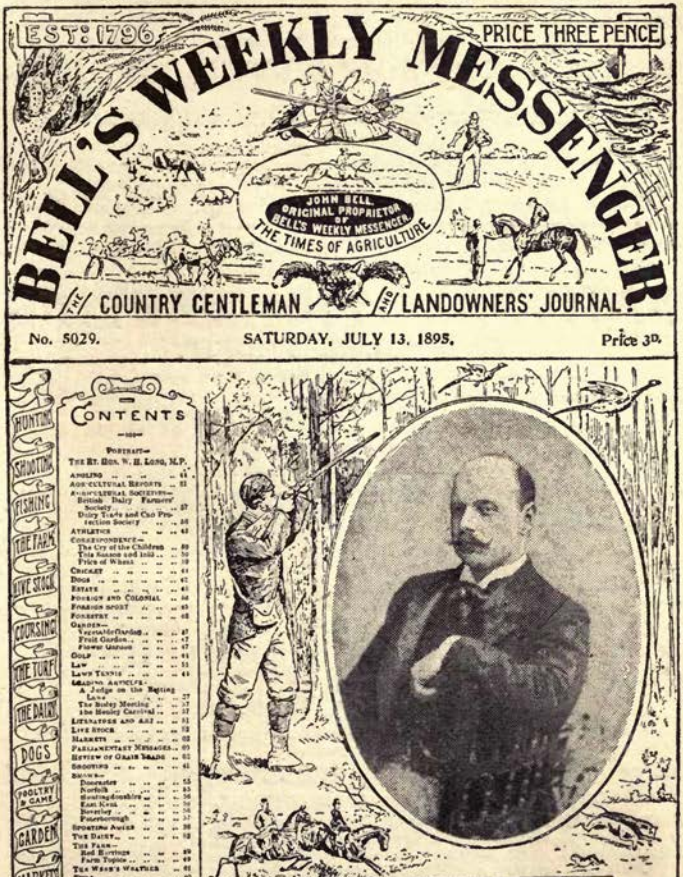

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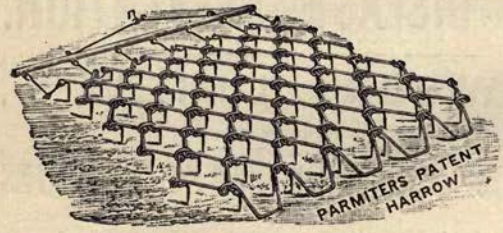

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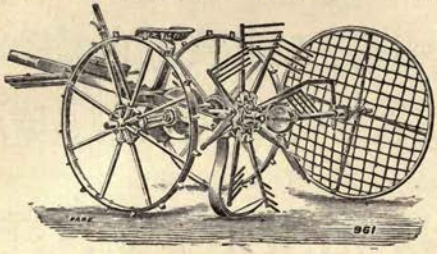

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